ANRITSU
MF76A

OPERATOR'S MANUAL

5N2

MP MASTER
MA30358

Anritsu

OPERATION MANUAL

MICROWAVE FREQUENCY COUNTER

MF76A

ANRITSU ELECTRIC CO., LTD.

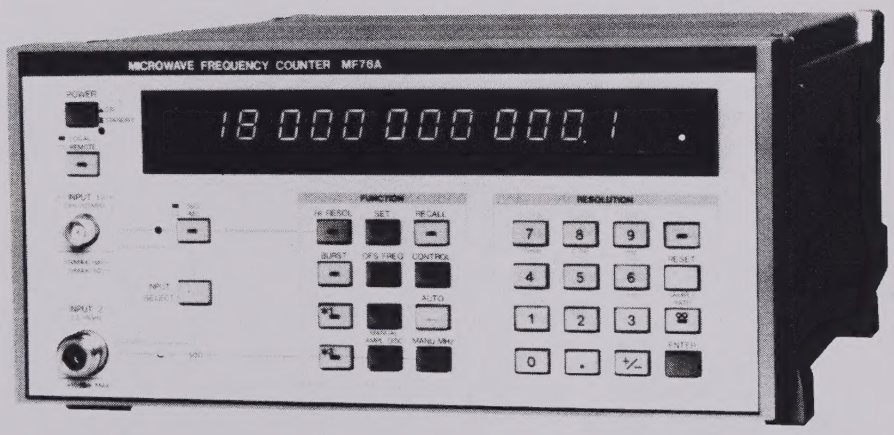
TOKYO, JAPAN

1984.07 × 100 NII-6(Y)

OPERATION MANUAL

MICROWAVE FREQUENCY COUNTER

MF76A



1984.07 × 100 NII-6(Y)

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N O T E

(1) The instrument is operable on a nominal voltage from 100 to 127 Vac or from 200 to 254 Vac by changing the connections of the power transformer taps.

The voltage and current rating are indicated on the rear panel when the instrument is shipped from the factory.

In the case of other voltage operation, change the connections of the power supply transformer, and the plate of voltage and current designations on the rear panel should be changed to suitable one.
Order the plates to Anritsu Electric Co., Ltd. if necessory.

(2) In this manual, a power supply voltage and current rating are represented by [**] Vac and [***] A.

(3) The relation between power supply voltage and current rating is listed below.

** Vac	*** A
100 to 127 V	1.6 A
200 to 254 V	0.8 A

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SECTION 1

GENERAL

The MF76A Microwave Frequency Counter automatically measures a wide frequency range from 10 Hz to 18 GHz with high sensitivity, high accuracy, and high precision.

A direct counting system is utilized to measure frequencies from 10 Hz to 200 MHz and a heterodyne down converter system is used for the range from 0.2 to 18 GHz. This high-performance counter has a wide FM tolerance of 50 MHzp-p and can measure frequencies in any band with a resolution of 1 Hz within one second.

The various functions of this counter are enabled by an 8-bit microprocessor (CPU), including fully automatic frequency measurement, operation functions such as display of sum, difference, and parts per million (ppm), low-frequency high-resolution measurement, and burst signal measurement. In addition, the optional built-in GP-IB allows the counter to be linked with a computer system and external devices, making the counter suitable for system expansion.

The measurement result is stored and displayed in twelve digits, each on a 7-segment green LED (light emitting diode). This counter is overflow-free, even when measuring at 0.1 Hz resolution, and the zero-blanking system provides a neat, legible display.

SECTION 2

COMPOSITION AND SPECIFICATIONS

2.1 COMPOSITION

Table 2-1 shows the standard composition of the MF76A Microwave Frequency Counter and Table 2-2 shows the available options and optional accessories respectively.

Table 2-1 Standard Composition

Item	Name	Q'ty	Remarks
Instrument	MF76A Microwave Frequency Counter	1	
Accessories	Coaxial cable 1m	1	3CA-P2·RG58A/U·3CA-P2
	Coaxial cable 1m	1	UG21D/U·RG9A/U·UG21D/U
	Power cord 2.5m	1	
	Power cord adapter	1	Double-pole receptacle conversion adapter
	Fuse ***A	1	Primary side MF51NN 250 V ***AAC05
	Fuse 1A	1	Secondary side MF51NN 250 V 1ADC01
	Fuse 2A	1	Secondary side MF51NN 250 V 2ADC01
	Operation Manual	1	

Table 2-2 Options and Optional Accessories
(separate contract)

Item	Name	Remarks
Option	OP-01 crystal oscillator	Aging rate: $\leqq 5 \times 10^{-9}$/day
	OP-02 crystal oscillator	Aging rate: $\leqq 2 \times 10^{-9}$/day
	OP-03 Crystal oscillator	Aging rate: $\leqq 5 \times 10^{-10}$/day
	OP-06 GP-IB interface	
Optional accessories	Coaxial cable	3CA-P2·RG58A/U·alligator clip
	Coaxial cable	SMA-P·Special·3D-2W·SMA-P
	Coaxial adapter	N-P·SMA-J
	Coaxial to waveguide adaptor	
	MP721A to H Attenuator	Up to 12.4 GHz, 3 to 60 dB
	GP-IB bus connecting cable	
	ICC-2 conversion connector	GP-IB·IEC-IB conversion adapter
	Carrying case	
	Carrying bag	
	Protection cover	Front, Rear

2.2 SPECIFICATIONS

Table 2-3 lists specifications of the MF76A and Table 2-4 lists specifications of the optional reference oscillator.

Table 2-3 Specifications

		INPUT 1	INPUT 2
Input	Frequency range	10Hz to 200MHz 100kHz to 200MHz (BURST) 10Hz to 1MHz (HI RESOL 1mHz) 10Hz to 10MHz (HI RESOL 10mHz) 10Hz to 20MHz (HI RESOL 0.1, 1Hz)	0.2 to 18GHz
	Sensitivity (Sine wave)	50mVrms	-22dBm: 0.2 to 14GHz -15dBm: 14 to 18GHz
	Maximum input	10Vrms: 1MΩ 2Vrms: 50Ω	Max operating level: +10dBm Damage level: +20dBm
	Input impedance	≧1MΩ shunted by ≦ 40pF, 50Ω	50Ω
	Coupling/Connector	AC, BNC	DC, N
Frequency measurement	Resolution	0.1Hz, 1Hz, 10Hz, 100Hz, 1kHz, 10kHz, 100kHz, 1MHz	
		1mHz, 10mHz, 100mHz, 1Hz: HI RESOL	————
	Gate time	10s, 1S, 100ms, 10ms, 1ms, 100μs, 10μs, 1μs	
		≦ 20s: 1mHz ≦ 16s: 10mHz ≦ 5s: 100mHz ≦0.5s: 1Hz } HI RESOL	————
	FM tolerance	————	50MHz p-p: 0.5 to 18GHz 25MHz p-p: 0.2 to 0.5GHz
	Acquisition time	————	≦ 600ms
	Accuracy	±1 count ± time base accuracy	
		±(1 count + time base accuracy + trigger error): HI RESOL	————

Table 2-3 Specifications (Cont'd)

			INPUT 1	INPUT 2
	Unit indication		GHz, MHz; kHz, and Hz	————
			MHz, kHz, Hz, and mHz : HI RESOL	————
General specifications	Offset mode		Addition, difference and ppm to and from the selected value are displayed.	
	Display system		12-digit and "-" sign display 1 digit, 7 segment green LED, zero blanking, storage display	
	Sample rate		Approximately 0.08, 0.8, 2s and ∞ : selected from SAMPLE RATE switch Approximately 20ms to 9999min: selected from ten keys	
	Reference Oscillator	Frequency	10MHz	
		Starting characteristic	$\leqq 5 \times 10^{-8}$/day (after 30 minutes warm-up)	
		Aging rate	$\leqq 2 \times 10^{-8}$/day	
		Temperature characteristic	$\pm 5 \times 10^{-8}$ (25 ± 25°C)	
	Power		AC **V $^{+10}_{-15}$%, 50/60 Hz ±5%, when started≦100VA, under normal operation ≦ 85VA	
	Dimensions		132.5H, 284W, 351Dmm (excluding such protrusions as handles, rubber feet, etc.)	
	Weight		≦ 12kg	
	Ambient temperature, rated range of use		0 to 50°C	

The aging rates of the standard crystal oscillator are 4×10^{-8}/week or less, 8×10^{-8}/month or less, and 1×10^{-7}/year or less.

Table 2-4 Specifications of the Optional Reference Oscillator

Item	OP-01	OP-02	OP-03
Starting characteristics	$\leqq 3 \times 10^{-8}$/day (after one hour operation)	$\leqq 2 \times 10^{-8}$/day (after one hour operation)	————
Aging rate	$\leqq 5 \times 10^{-9}$/day (after 24 hours operation)	$\leqq 2 \times 10^{-9}$/day (after 24 hours operation)	$\leqq 5 \times 10^{-10}$/day (after 48 hours operation)
Temperature characteristics	$\pm 5 \times 10^{-8}$ (25°C ± 25°C)	$\pm 1.5 \times 10^{-8}$ (25°C ± 25°C)	$\pm 5 \times 10^{-9}$ (25°C ± 25°C)
Output	10 MHz, $\geqq$ 2Vp-p (open circuit voltage), $\leqq 400\ \Omega$		

SECTION 3

OPERATION

3.1 SAFETY PRECAUTIONS

(1) The external conductors of the N and BNC connectors are connected to the chassis and float in relation to the AC power supply, and therefore may cause shock when connected to other devices. To prevent this, the center ground pin of the triple-pole power cord or the GND terminal on the rear panel must always be grounded. When a power cord adapter is used to connect the power cord triple-pole plug to a receptacle, the green line from the power cord adapter must be grounded.

(2) Ensure that the line voltage to be used is the same as the value indicated on the rear panel.

(3) * Connect the power cord only after varifying that the POWER switch on the front panel is in the STANDBY position (the switch button is up).

* (Connect the power cord only after verifying that the LINE switch on the rear panel is in the OFF position --- for IEC safety standard.)

(4) To replace a blown fuse, remove the power cord from the receptacle, turn on the POWER switch (the switch is pressed) for several seconds, then set it in the STANDBY position again.

(5) The instrument may be short-circuited due to condensation after use in a low temperature environment or outdoors for an extended period of time. Allow the instrument to dry out before using it again at the room temperature or indoors.

3.2 LAYOUT OF CONTROLS

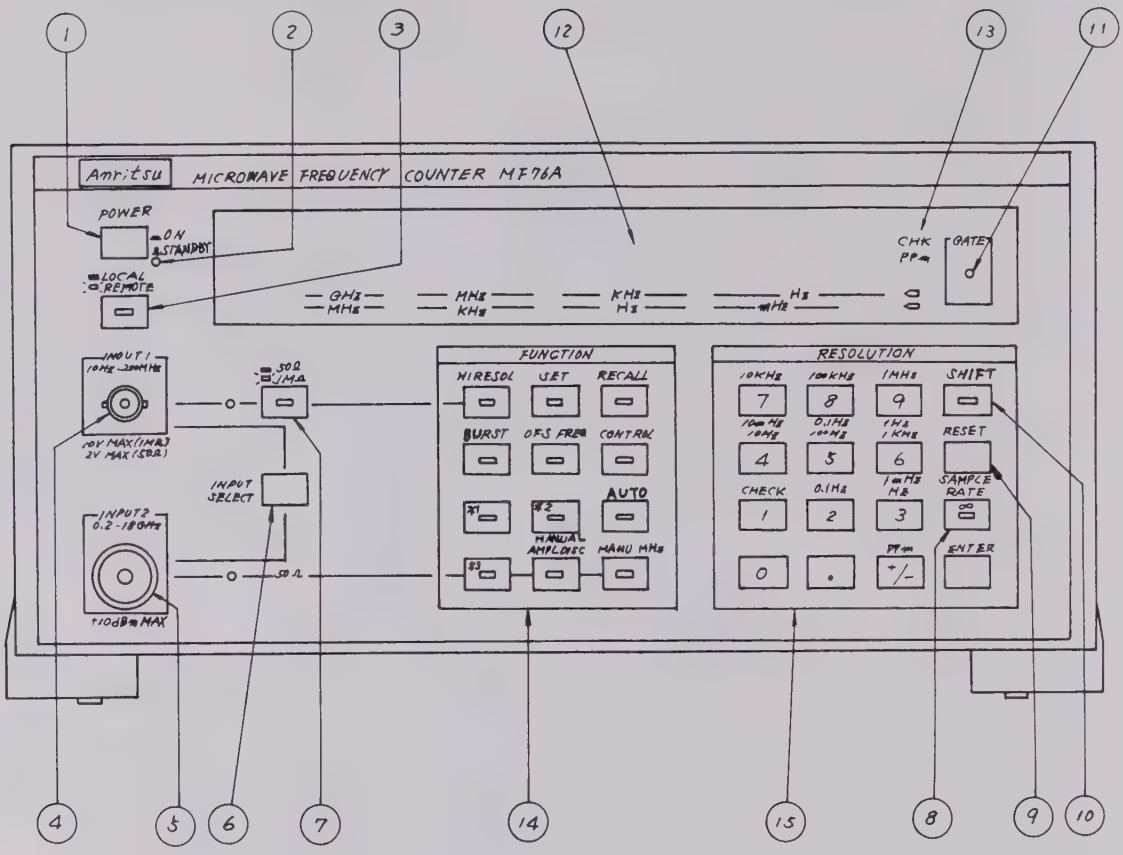


Fig. 3-1 Front Panel

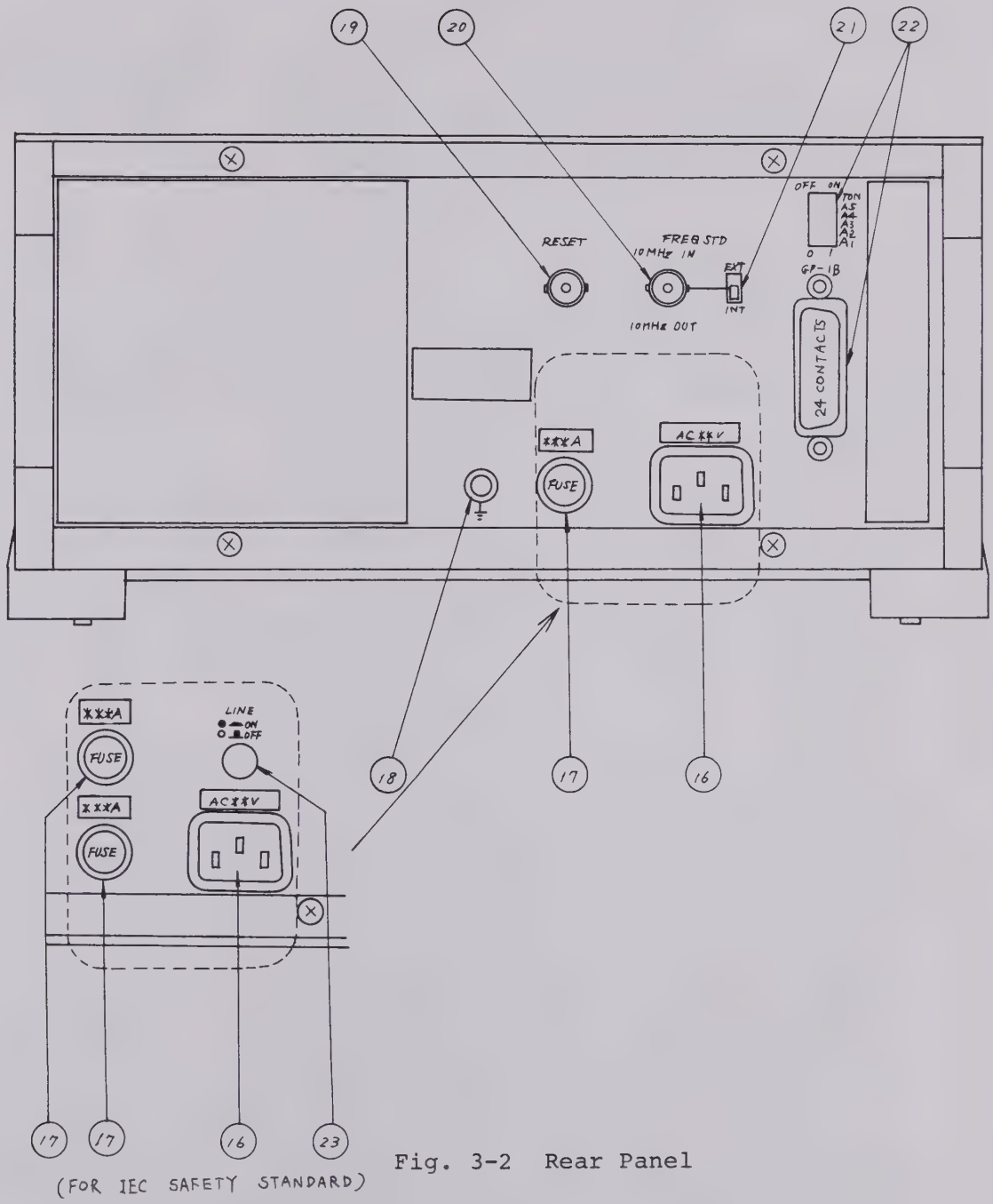


Fig. 3-2 Rear Panel

3.3 DESCRIPTION OF CONTROLS

The layout of the connectors, and switches is shown in Figs. 3-1 and 3-2. The functions of these connectors, controls, and switches are described in Table 3-1.

Table 3-1 Explanation of Controls

No.	Symbol	Description
(1)	POWER ON STANDBY	Power switch. This switch is ON when it is depressed (* with the LINE switch (23) on the rear panel set at ON.) Power is supplied to the internal circuits setting the instrument in operating status. Power is disconnected (STANDBY) when this switch is pressed again and the button pops out (STANDBY). Power is supplied to the thermostatic oven and the crystal oscillator circuit when this switch is in STANDBY position and the power cord is connected to the ac line (* when the LINE switch on the rear panel is ON). * - - - For IEC Safety Standard
(2)		This lamp lights up when the POWER switch is in STANDBY status. The crystal oscillator circuit is operating in this status, and the reference signal is output from the FREQ STD 10 MHz OUT connector (20) on the rear panel.
(3)	LOCAL REMOTE	If the instrument is being set by instructions from an external controller, it is in the remote mode and the LED built into the key is lit. Push the key to switch the instrument from remote to local mode. The key LED is off when the instrument is in local mode, and settings are made from the front panel. Some conditions specified by the external controller may not permit the instrument to be set in local mode, and the instrument may not be set into remote mode directly from this key.

Table 3-1 Explanation of Controls (Cont'd)

No.	Symbol	Description
④	INPUT 1	This is the input connector for the signal under measurement, in the frequency range of 10 Hz to 200 MHz.
⑤	INPUT 2	This is the input connector for the signal under measurement, in the frequency range of 0.2 to 18 GHz. The input impedance is 50 Ω.
⑥	INPUT SELECT	This switch is used to select INPUT 1 or INPUT 2. Each time this switch is pushed, INPUT 1 and INPUT 2 are switched alternatively and the LED next to the selected input connector lights up.
⑦	▬ 50Ω 1 MΩ	This is the input impedance selection switch for INPUT 1. Each time the switch is pushed, 1 MΩ high input impedance and 50 Ω impedance are switched alternatively. When 1 MΩ is selected the key LED is lit, and when 50 Ω is selected the LED is off.
⑧	SAMPLE RATE	This key is used to select and set the sample rate. Four sample rates available: approximately 80 ms, 0.8 s, 2 s, and infinity. The sample rate is switched from 80 ms to 0.8 s to 2 s, and then to infinity as the key is pushed. When infinity is selected, the key LED is lit and the previous display is retained. The sample rate may be set within the range of approximately 20 ms to 9999 min. To clear the setting and return to the normal sample rate, push this key, and the infinity status can be selected.

Table 3-1 Explanation of Controls (Cont'd)

No.	Symbol	Description
(9)	RESET	This key is used to reset the counting operation and to clear key operations. When the key is pushed, the display is erased and another measurement may be made. If the sample rate is set to infinity, only one measurement is made when the key is pushed. When this key is pushed during key operation, any key whose LED is blinked is cleared. If this key is pushed while data is being set, only the input data is cleared.
(10)	SHIFT	This key is used to set resolution, switch the CHECK operation, and set ppm (parts per million) operation. When the key is pushed, the key LED blinks and the corresponding numeric key is switched to the RESOLUTION key displayed in blue or green characters.
(11)	GATE	This LED lights up during counting operations including an arithmetic operation. When this LED goes off, the measurement result is displayed on the display (12).
(12)		This is a 12-digit and 1-digit symbol display, 7-segment LED indicator used to display the measurement result. The 12-digit LED display is sectionalized into GHz, MHz, kHz and Hz (MHz, kHz, Hz and mHz in HI RESOL operation), eliminating shifting decimal points and digit overflow. Since the zero-blanking system is adapted, unnecessary zeros are not displayed.

Table 3-1 Explanation of Controls (Cont'd)

No.	Symbol	Description
(13)		Characters representing the unit of measurement or the type of operation are indicated. Normally, ◁ lights up at the position of GHz, MHz, kHz, Hz and the corresponding measurement result is displayed. The ◁ lights up at the position of MHz, kHz, Hz, mHz during HI RESOL operation. In the deviation parts per million operation, the characters ppm are indicated. In the CHECK operation, the characters CHK representing the type of operation are indicated.
(14)	FUNCTION	This key group is used to select and clear functions. During operation, the LED in the key that is pushed blinks. Upon completion of operation, the key LED is lit.
	HI RESOL	This key is used to select and clear the low-frequency, high-resolution measuring function in the INPUT 1 frequency range.
	SET	Used to select the data set mode.
	RECALL	Used to select the function to call set data.
	BURST	Used to select and clear the burst signal measuring function.
	OFS FREQ	Used to select and clear the offset operation function of frequency measurement.
	CONTROL	Used to select the offset RENEWAL mode operation function of frequency measurement.
	AUTO	Used to select the automatic measurement function in the INPUT 2 frequency range and to clear the manual measurement function.

Table 3-1 Explanation of Controls (Cont'd)

No.	Symbol	Description
	MANUAL AMPL DISC	Used to switch between the automatic and manual amplitude discrimination function in the INPUT 2 frequency range.
	MANU MHz	Used to select the manual measurement function in the INPUT 2 frequency range.
	*1, *2, *3	Reserved for an optional function to be added in the future.
(15)	RESOLUTION	This key group is used to set resolutions or data. The function of this key group is switched by SHIFT key (10) for resolution set or data set.
(16)	AC**V	Power connector for connecting the power cord. Connect this connector to ac line using attached power cord.
(17)	FUSE ***A	***A fuse for the primary side power line.
(18)	⏚	Ground terminal. This terminal must be grounded for the safety.
(19)	RESET	The counting operation may be reset by applying 0V. When the RESET key (9) on the front panel is pushed 0V is output from this connector.
(20)	FREQ STD 10 MHz IN 10 MHz OUT	Input/output connector of the reference signal. When the FREQ STD selection switch (21) is set at INT, this connector is the output connector that outputs the 10 MHz signal of the built-in reference oscillator; when set at EXT, this connector is the input connector of the external reference signal.
(21)	FREQ STD EXT INT	Switches the internal and external reference signals. Normally set at INT for internal crystal oscillator operation. When set at EXT,

Table 3-1 Explanation of Controls (Cont'd)

No.	Symbol	Description
		the instrument operates by an external reference signal.
(22)	GP-IB	The GP-IB interface (option 06) is installed here for measurement result output or for external equipment control.
(23)*	LINE ● ⊓ ON ○ ⊓ OFF	LINE switch. When the button is pressed, the switch comes on and the power for the internal circuits can be turned on/off with the POWER switch (1) on the front panel. When this switch is pushed again and the button pops out, the switch turns off and power to all circuits is disconnected.

* ... FOR IEC SAFETY STANDARD

3.4 PREPARATIONS FOR MEASUREMENT

3.4.1 Precautions

A predetermined warm-up time is required so that the frequency of the crystal oscillator can reach the rated stability (see the reference oscillator data in Tables 2-3 and 2-4). The thermostatic crystal oven and the crystal oscillator circuits, etc. of the instrument are always operating as long as the power cord is connected to ac line (* with the LINE switch on the rear panel at ON), even when the POWER switch (1) on the front panel is at STANDBY. Unplug the power cord from the ac line receptacle (* or set the LINE switch on the rear panel in OFF position) to completely disconnect the instrument circuitry.

* --- For IEC Safety Standard

3.4.2 Verification of Line Voltage

Verify that the line voltage to be used agrees with the rated voltage indicated on the rear panel.

3.4.3 Power Supply Connection

Verify that the POWER switch (1) on the front panel is in the STANDBY position *(the LINE switch on the rear panel is OFF). Then, connect the power connector on the rear panel to the ac line receptacle with the attached power cord. The STANDBY lamp on the front panel lights up in this status *(when LINE switch on the rear panel is ON).

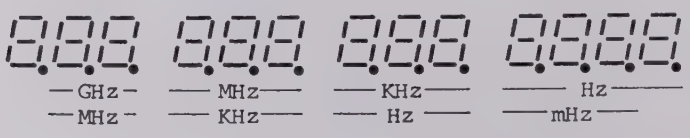
* --- For IEC Safety Standard

3.4.4 Internal/External Switching of Reference Signal

Since the internal crystal oscillator is generally used, verify that the FREQ STD EXT/INT selection switch (21) on the rear panel is at INT. To use the external reference signal, set the switch in the EXT position and then input the 10 MHz signal of the TTL level to the FREQ STD IN/OUT connector.

3.4.5 Power On

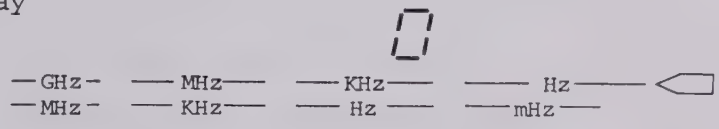
When the POWER switch (1) on the front panel is set at ON, the self-diagnostic function runs automatically and all digits of the 7-segment LED are displayed as shown below:



All digits are blanked approximately 1.5 seconds later, and the unit display and the key LED lights up for approximately 1.5 seconds. Visually check the LED display in this status.

3.4.6 Initialization

If the self-diagnostic function results are normal, the relevant initial values are set as follows:

INPUT SELECT	INPUT 2
RESOLUTION	1 kHz (1 ms)
SAMPLE RATE	Approximately 80 ms
Display	
AUTO	AUTO (The key LED is lit.)
OFFSET	OFF (OFS FREQ The key LED is extinguished.)
GATE display	Blinking at an approximately rate of 80 ms.
Other functions	All cleared.
Set values	All cleared.

*** Precautions ***

- If the reference signal is not input when the FREQ STD EXT/INT selection switch (21) on the rear panel is set at EXT, the LED will not light up even if the POWER switch on the front panel is ON.
- Manipulate the FREQ STD EXT/INT selection switch only after setting the POWER switch (1) on the front panel in the STANDBY position.
- When the power comes back on after any interruption, all functions and settings are initialized and are set in the same status as that held immediately after the power is turned on. Therefore, the functions must be selected and values must be set again.

3.4.7 Key Operations and Display of Built-in LED

Function selection may require one or a series of key operations.

If a series of key operations is required, when a key operation is accepted, the LED in the operated key blinks at rate of about 80 ms or message is displayed on the display (12). When all required key operations are completed and the desired function is selected, the blinking key LED goes off, all digits displayed on the display (12) are cleared, and the selected function starts to operate. At this time, the LED in the key used for setting the FUNCTION lights up to indicate the operating function.

For example, to select the resolution function, the SHIFT key (10) is pushed to switch the numeric key to the RESOLUTION key indicated in blue characters. The key LED blinks in this status, the counting operation is

halted in the key operation mode awaiting the next key operation. If the 0.1Hz / 2 key (15) is pushed next, the blinking LED in the SHIFT key (10) goes off, all digits displayed on the display (12) are cleared, and the mode is switched to the 0.1 Hz resolution measuring operation.

Since the microprocessor always monitors and determines the current status of key operation, any irrelevant key operations are ignored. Therefore, another function may not be selected during the course of a series of key operations; that is, the series of key operations must be completed or the function being selected must be cleared first. Push either the first key manipulated or the RESET key (9) to clear the function being selected. Observe the following when entering a series of key operations:

(1) Prior to selecting a function, always verify that the previously selected function has been set (i.e., no other key LED is blinking).

(2) Push the next key only after verifying that the previous key operation has been accepted and the key LED is blinking.

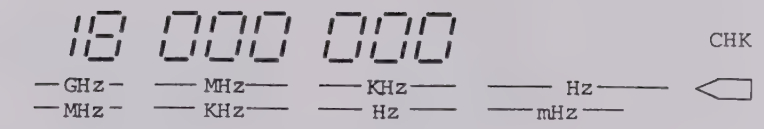
(3) Manipulate keys correctly in the prescribed order.

3.4.8 Checking Internal Operations

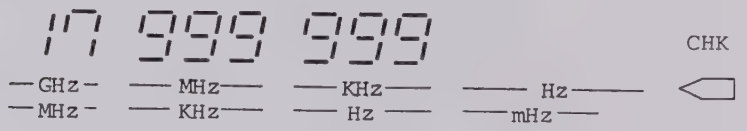
Manipulate the following keys in the order indicated from the initialization status:

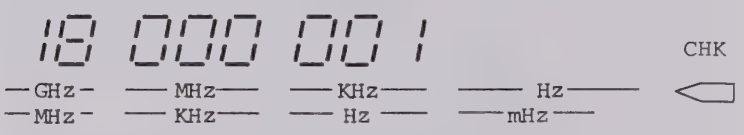
(1) Push the SHIFT key (10). The key LED blinks.

(2) Push the CHECK / 1 key (15). Verify that the LED the SHIFT key (10) goes off and that the display (12) reads 18 GHz as shown below:

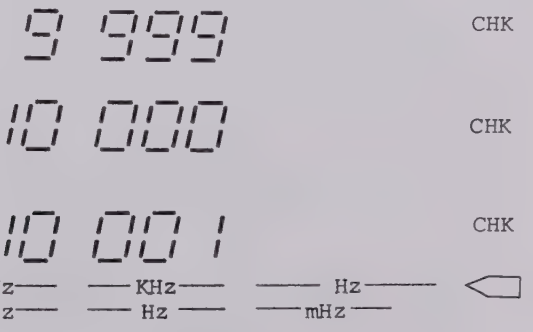


Note: This status shows that the reference signal has been measured at 1 kHz resolution and harmonic number has been checked. The display may be ±1 count as shown below due to the ±1 count error inherent in the digital counter. However, operation of this instrument is normal.





(3) Push the INPUT SELECT ☐ key (6) and verify operation of the INPUT 1 range. Also, verify that 10 MHz appears on the display (12). The display may be ±1 count as shown below. However, operation of this instrument is normal.



(4) Push the INPUT SELECT ☐ key (6) again to return to INPUT 2 range operation.

(5) Switch the RESOLUTION and verify that the display is as shown below:

Operation	Resolution	Display	
SHIFT [▭] , 1 MHz [9]	1 MHz	18 000	CHK
SHIFT [▭] , 100 kHz [8]	100 kHz	18 000 000	CHK
SHIFT [▭] , 10 kHz [7]	10 kHz	18 000 000	CHK
SHIFT [▭] , 1 kHz [6]	1 kHz	18 000 000	CHK
SHIFT [▭] , 100 Hz [5]	100 Hz	18 000 000 000	CHK
SHIFT [▭] , 10 Hz [4]	10 Hz	18 000 000 000	CHK
SHIFT [▭] , 1 Hz [3]	1 Hz	18 000 000 000	CHK
SHIFT [▭] , 0.1 Hz [2]	0.1 Hz	18 000 000 000.0	CHK

—GHz— —MHz— —KHz— —Hz— ◁
—MHz— —KHz— —Hz— —mHz—

(6) This completes the verification of internal operations. Push the SHIFT [▭] key and the CHECK [1] key, in that order, to clear the CHECK operation. The CHK display goes off and the display will be as shown below (no input signal, resolution is 0.1 Hz)

0.0

—GHz— —MHz— —KHz— —Hz— ◁
—MHz— —KHz— —Hz— —mHz—

3.4.9 Resolution and Display

(1) Resolution

The resolution (the minimum read value of display) is set with the RESOLUTION key. When the SHIFT [▭] key (10) is pushed, the key LED blinks and the numeric key is switched to the RESOLUTION key. When any one of 0.1Hz [2] to 1MHz [9] keys (15) is pushed in succession, the LED in the SHIFT [▬] key (10) goes off and the resolutions are set. Individual resolutions are set as shown below:

0.1 Hz	:	SHIFT [▭] , 0.1 Hz [2]
1 Hz	:	SHIFT [▭] , 1 Hz [3]
10 Hz	:	SHIFT [▭] , 10 Hz [4]
100 Hz	:	SHIFT [▭] , 100 Hz [5]
1 kHz	:	SHIFT [▭] , 1 kHz [6]
10 kHz	:	SHIFT [▭] , 10 kHz [7]
100 kHz	:	SHIFT [▭] , 100 kHz [8]
1 MHz	:	SHIFT [▭] , 1 MHz [9]

1mHz [3] to 1Hz [6] keys (15) displayed in green characters are used to set the HI RESOL operation. The initial value automatically becomes 0.1Hz resolution when the HI RESOL mode is selected.

1 mHz : SHIFT [ ], 1 mHz [3]

10 mHz : SHIFT [ ], 10 mHz [4]

0.1 Hz : SHIFT [ ], 0.1 Hz [5]

1 Hz : SHIFT [ ], 1 Hz [6]

Refer to 3.4.8(5) for changes in displays for resolutions. Table 3-2 and Fig. 3-3 show the relationship between the set resolution and counting time.

Table 3-2 Relationship between Resolutions and Counting Time

Resolution	Counting Time
1 MHz	1 µs
100 kHz	10 µs
10 kHz	100 µs
1 kHz	1 ms
100 Hz	10 ms
10 Hz	100 ms
1 Hz	1 s
0.1 Hz	10 s

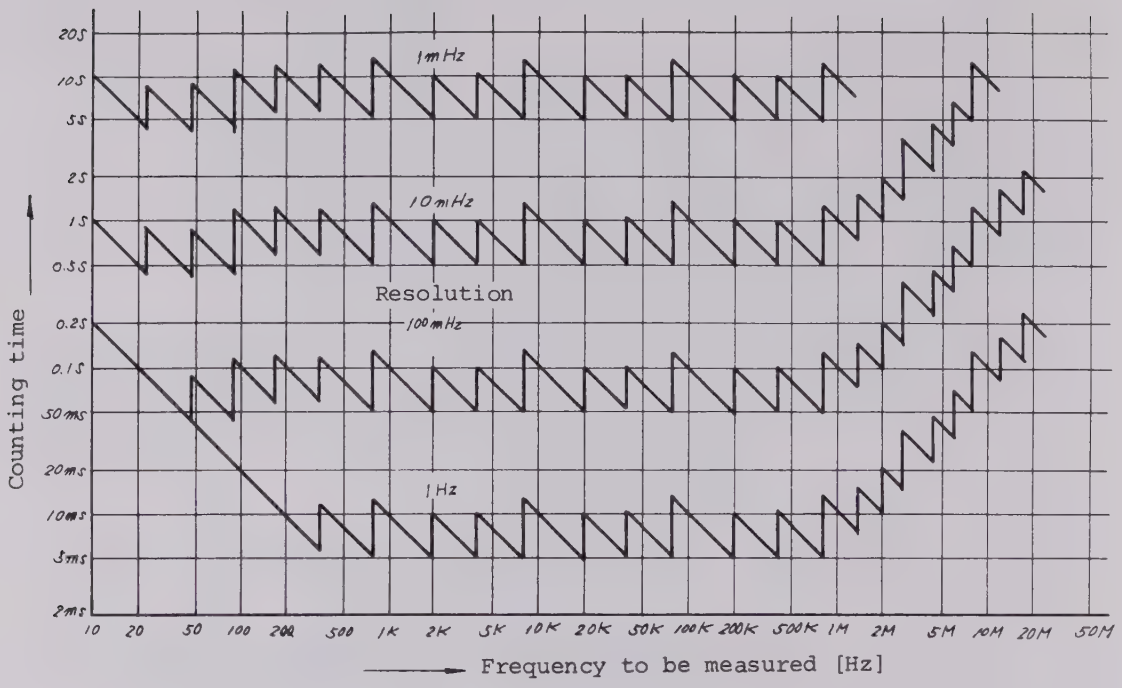


Fig. 3-3 Relationship between Resolutions and Counting Time during HI RESOL Operation

(2) GATE display

In the INPUT 1 frequency range, the GATE display comes on and remains on to indicate a counting operation only for the period determined by RESOLUTION, irrespective of whether the input signal is present.

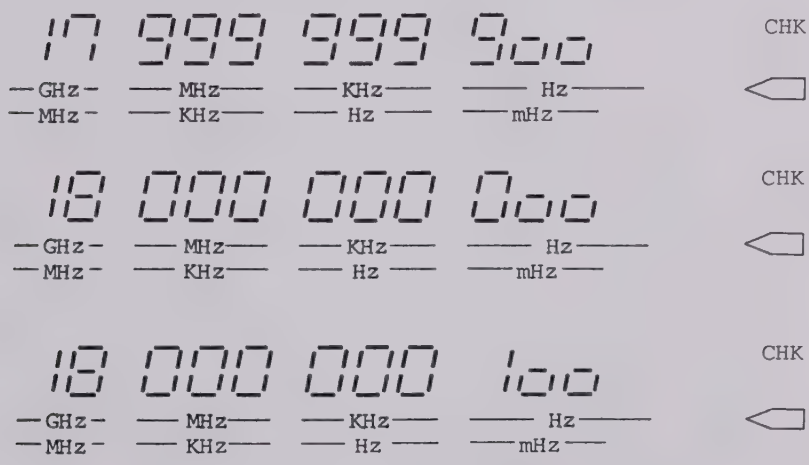
In the INPUT 2 frequency range, the GATE display blinks for approximately 100 ms if no input signal is present, irrespective of RESOLUTION. If the input signal is applied, it is lit for the entire period including the acquisition time, operation time, and counting time. For a HI RESOL or a BURST operation, the GATE display does not light up unless the input signal is present.

The GATE display is designed to be lit longer than the actual counting time because it is difficult to verify it when the counting time is short.

(3) 7-segment LED display

To facilitate interpretation of the readings, this display as far as the least significant unit for digits of each unit under the resolution by adding 0 . This added 0 is different from 0 of the measurement result and is irrelevant to the counting operation. Therefore, the ±1 count error of the measurement, if any, occurs at the position where RESOLUTION is set.

For example, if RESOLUTION is set at 100 Hz for the CHECK operation of INPUT 2, the ±1 count error, if any, will appear as shown below:



3.4.10 Sample Rate

One of four sample rates (approximately 80 ms, 0.8 s, 2 s, and infinity) may be selected by means of the SAMPLE RATE key (8).

The sample rate may also be set within the range of approximately 20 ms to 9999 min with numeric keys (15).

(1) Setting RESOLUTION by means of SAMPLE RATE key (8)

The sample rate is automatically initialized at approximately 80 ms when the power is turned on.

Each time the SAMPLE RATE key (8) is pushed, the sample rate is switched in the sequence of 80 ms ⟶ 0.8 s ⟶ 2 s ⟶ infinity ⟶ 80 ms .....

When the sample rate is set to infinity, the LED in the SAMPLE RATE key (8) lights up and display on the display (12) is held until one of the following operations is performed:

(a) When the RESET key is pushed: RESET

(b) When RESOLUTION is set: SHIFT , 0.1Hz - 1MHz (2 - 9)

(c) When INPUT 1 and INPUT 2 are switched: INPUT SELECT

(d) When the HI RESOL mode is set or cleared: HI RESOL

(e) When the BURST mode is set or cleared: BURST

(f) When the OFFSET mode is set: OFS FREQ , ENTER or SET , OFS FREQ , data, ENTER

(g) When the sign is altered in the OFFSET mode: +/-

(h) When the ppm mode is set in the OFFSET mode:

SHIFT , ppm (+/-)

(i) When the ppm mode is cleared in the OFFSET mode:

ppm (+/-)

(j) When the OFFSET mode is cleared: OFS FREQ

(k) When the MANUAL AMPL.DISC mode is set:

MANUAL AMPL.DISC or

SET , MANUAL AMPL.DISC ,

0 - 7 , ENTER

(l) When the MANUAL AMPL.DISC mode is cleared:

MANUAL AMPL.DISC

(m) When the MANUAL mode is set: MANU MHz or

: SET , MANU MHz ,

data, ENTER

(n) When the MANUAL mode is cleared: AUTO

(o) When the key operation is cleared: SET , SET

and SHIFT , SHIFT ETC.

(p) When a RECALL or CHECK operation is set or cleared.

(q) When the reset signal is applied to the RESET connector on the rear panel.

(2) Setting SAMPLE RATE by means of numeric keys (15)

The sample rate can be set within the range of 20 ms to 9999 min (approximately 7 days). Three sample rate units--60 sec (1 minute), 1 sec (1 second), and 0.001 sec (1 ms) -- are available. A maximum of four digits may be set for each sample rate.

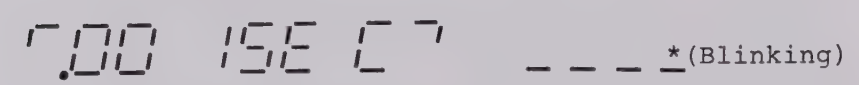
When the SET key (14) and the SAMPLE RATE key (8) are pushed in this order, the display will be as below:

*(Blinking)

This status indicates that the sample rate setting unit is to be treated as 60 sec (1 minute). Each time the [·] key (15) is pushed, the unit is switched in the sequence of 60 sec (1 minute) ⟶ 1 sec (1 second) ⟶ 0.001 sec (1 ms) ⟶ 60 sec .. ... The desired sample rate may be set by aligning the unit first, followed by the data.

(a) Setting the range of 20 ms to 9999 ms

When the SET [▭], SAMPLE RATE [∞] (8), [·] (15), [·] (15) keys are pushed in this order, the display will be as shown below.



*(Blinking)

Then, use the numeric keys (15) to input the desired time. To alter the input data, push the RESET [ ] key (9) and then input the data again.

Push the ENTER [ ] key (15) after verifying the set data and unit to complete the sample rate setting.

[Example] Set the sample rate to 20 ms.

SET , SAMPLE RATE , [·] , [·]

*(Blinking)

[2] , [0]

ENTER

(b) Setting the range of 1 s to 9999 s

When the SET key (14), SAMPLE RATE key (8), and [·] key (15) are pushed in this order, the display will be as shown below:

*(Blinking)

Then, input the desired time using the numeric keys in the same manner as described in 3.4.10 (2) (a) above. When the setting is completed, the LED in the SAMPLE RATE key (8) blinks at a rate of one second.

[Example] Set the sample rate to 210 s (3.5 minutes).

SET , SAMPLE RATE , [·]

*(Blinking)

[2] , [1] , [0]

ENTER

(c) Setting the range of 1 min to 9999 min

When the SET key (14) and the SAMPLE RATE key (8) are pushed in this order, the display will be as shown below.

*(Blinking)

Then, input the desired time using the numeric keys. The data is input in the same manner as described in 3.4.10 (2) (a).
When the setting is completed, the LED in the SAMPLE RATE key (8) blinks at a rate of one second.

[Example] Set the sample rate to 1440 min (1 day).

SET , SAMPLE RATE

*(Blinking)

1 , 4 , 4 , 0

ENTER

(3) Clearing sample rate set with numeric keys (15)

Push the SAMPLE RATE key (8) to clear the sample rate that is set by means of numeric keys.

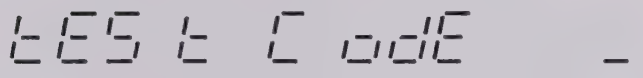
The LED in the SAMPLE RATE key (8) lights up and the infinity status in the mode set by the normal SAMPLE RATE key switch is resumed. For the subsequent settings, refer to 3.4.10 (1).

3.4.11 Checking LED Display and Key Operation

Use the keyboard test function (test code 20) described below to verify the LED display on the front panel and the key operations.

(1) Test function setting

When the SET key (14) and the CHECK 1 key (15) are pushed in this order, the following characters are displayed and the test code may be input:



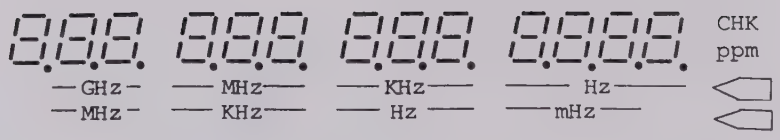
*(Blinking)

Then, 2 , 0 (test code 20) is input by the numeric key (15).

The keyboard test function can be set when the ENTER key (15) is pushed.

(2) Checking LED display

In the initial status of keyboard test function setting the display (12) is as shown below:

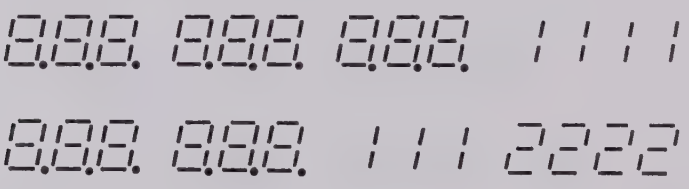


Since all LEDs (except STANDBY) including those in the keys and on the front panel (GATE display, etc.) light up at the same time, check LEDs and display (12).

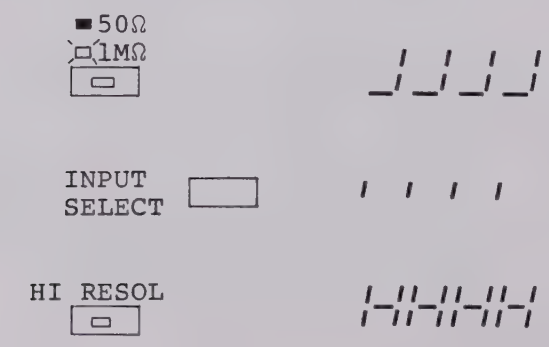
(3) Checking key

When a key is pushed, the corresponding characters are displayed in the low order four digits on the display (12) and the LED within the key lights. Each time a key is pushed, three digits of the previously displayed characters are moved to the higher order digits.

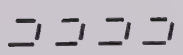
For example, if key [1] and key [2] are pushed in this order from the initial status shown in (2) above, the display will be as shown below:



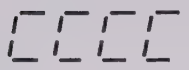
The correspondence between the operation keys and displays is as follows:



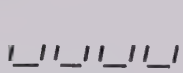
SET



RECALL



BURST



OFS FREQ

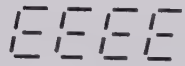
CONTROL

*1

*2

AUTO

*3

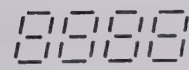


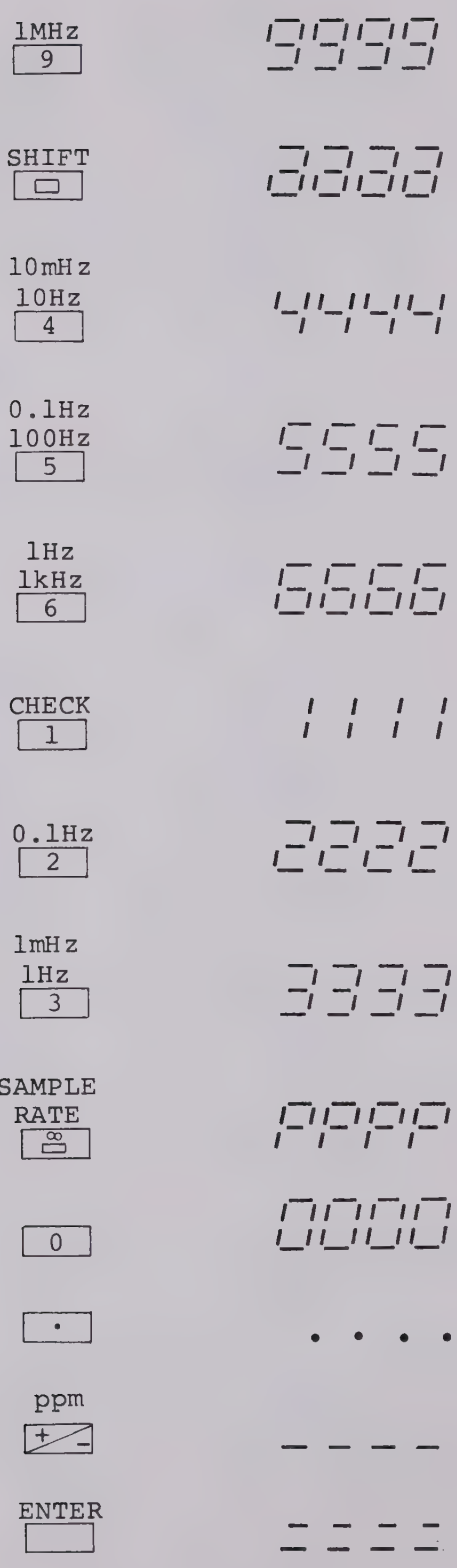
MANUAL
AMPL DISC

MANU MHz

10kHZ
7

100kHz
8




1MHz
9
9999
SHIFT
3333
10mHz
10Hz
4
4444
0.1Hz
100Hz
5
5555
1Hz
1kHz
6
6666
CHECK
1
1111
0.1Hz
2
2222
1mHz
1Hz
3
3333
SAMPLE
RATE
8
pppp
0
0000
.
. . . .
ppm
+/-
- - - -
ENTER
= = = =

(4) Clearing test function

When the RESET key (9) is pushed, the keyboard test function is cleared and the previous operating status is resumed.

3.5 MEASUREMENT

This subsection describes the following seven measuring functions:

(1) Normal frequency measurement within the frequency range from 10 Hz to 200 MHz (paragraph 3.5.1).
The continuous input frequencies in the frequency range of INPUT 1 are measured and displayed.

(2) High resolution measurement within the frequency range from 10 Hz to 20 MHz: HI RESOL mode (paragraph 3.5.2).
The continuous input frequencies within the frequency range of INPUT 1 are measured and displayed at high speed and high resolution using the reciprocal method.

(3) Normal frequency measurement within the frequency range from 200 MHz to 18 GHz: AUTO mode (paragraph 3.5.3).
The continuous input frequencies within the frequency range of INPUT 2 are automatically measured and displayed.

(4) Manual frequency measurement within the frequency range from 200 MHz to 18 GHz: MANUAL mode (paragraph 3.5.4).
This function is effective in measuring the known frequencies. The frequency is set within the range of ±40 MHz for the frequency to be measured to reduce the acquisition time.

(5) Manual amplitude discrimination within the frequency range from 200 MHz to 18 GHz: MANUAL AMPL. DISC mode (paragraph 3.5.5).
This function is effective when the level of the signal to be measured is known. The sensitivity is variable in 6 dB steps.

(6) Burst signal measurement within the frequency range from 100 kHz to 200 MHz: BURST mode (paragraph 3.5.6).
The pulse modulated input frequency within the frequency range of INPUT 1 is automatically measured and displayed.

(7) Burst signal measurement within the frequency range from 200 MHz to 18 GHz: BURST mode (paragraph 3.5.7).
The pulse modulated input frequency within the frequency range of INPUT 2 is measured and displayed.

3.5.1 Measurement of Frequencies between 10 Hz and 200 MHz

Normal, continuous input frequencies within the frequency range of INPUT 1 are measured.

3.5.1.1 Input Conditions

The allowable input conditions are as follows:

(1) Input frequency: 10 Hz to 200 MHz

(2) Input waveform : Sine wave or equivalent continuous wave

(3) Input voltage range:

Input impedance 1MΩ: 50 mV to 10 Vrms

Input impedance 50Ω: 50 mV to 2 Vrms

3.5.1.2 Connecting Input Signal

Apply the signal to be measured to the INPUT 1 connector (4) using the attached measuring coaxial cable.

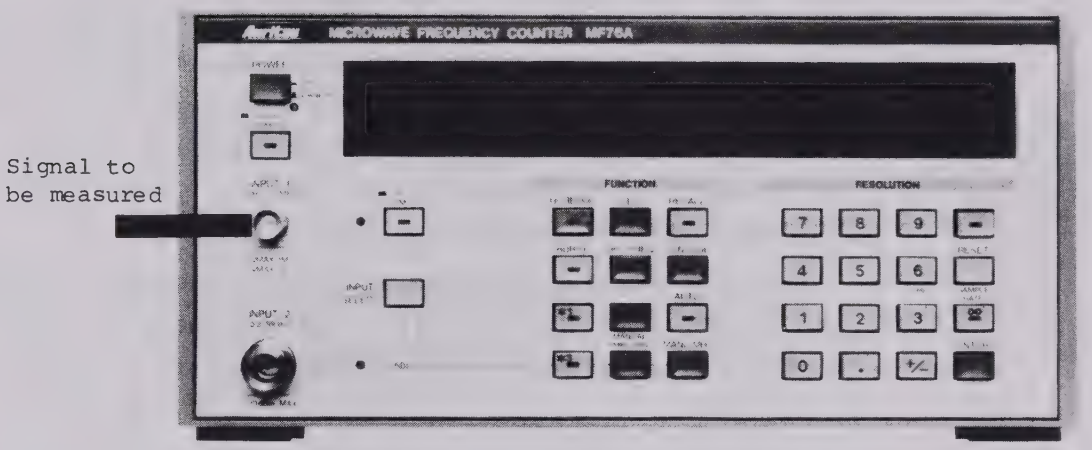


Fig. 3-4 Connection of INPUT 1

3.5.1.3 Settings

(1) Select the desired input impedance using the ▬ 50Ω / ▭ 1MΩ key (7). The LED within the key is off when 50 Ω is selected and is on when 1 MΩ is selected. The input impedance is automatically initialized at 50 Ω when power is turned on.

(2) Make the selection with the INPUT SELECT key (6) so that the LED on the INPUT 1 side lights.

(3) If the LED within the HI RESOL (14), BURST (14), or OFS FREQ (14) key is on, push the lit key. The LED turns off and the key is cleared.

(4) Set the desired measuring resolution using the RESOLUTION key (15). Refer to paragraph 3.4.9 for the setting method and counting time.

(5) Set the SAMPLE RATE as required. Measurements can be repeated at the desired speed. See paragraph 3.4.10.

The frequency of the input signal is displayed in this status. If the frequency of the input signal is not displayed at all or is not displayed correctly, verify the input signal referring to paragraph 3.5.1.1.

3.5.2 High Resolution Measurement

If the frequency to be measured is within the range from 10 Hz to 20 MHz, the HI RESOL mode can be specified to enable high resolution measurement with a short counting time.

3.5.2.1 Input Conditions

The allowable input conditions are as follows:

(1)	Input frequency:	10 Hz to 20 MHz
	Resolution 1 mHz:	10 Hz to 1 MHz
	Resolution 10mHz:	10 Hz to 10 MHz
	Resolution 0.1, 1 Hz :	10 Hz to 20 MHz
(2)	Input waveform:	Sine wave or equivalent continuous wave
(3)	Input voltage range:	
	Input impedance 1MΩ:	50 mV to 10 Vrms
	Input impedance 50Ω:	50 mV to 2 V rms

3.5.2.2 Connecting Input Signal

The signal to be measured is connected in the same manner as described in paragraph 3.5.1.2.

3.5.2.3 Settings

(1) Select the desired input impedance using the ■ 50Ω / □ 1MΩ key (7).
The LED in the key is off when 50 Ω is selected and is on when 1 MΩ is selected.
The input impedance is automatically initialized at 50 Ω when power is turned on.

(2) Make the selection with the INPUT SELECT key (6) so that the LED on the INPUT 1 side lights.

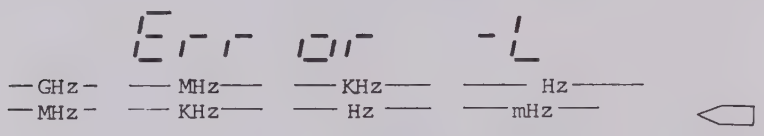
(3) If the LED within the BURST key (14) or the OFS FREQ key (14) is on, push the lit key.
The LED turns off and the key is cleared.

(4) Push the HI RESOL key (14). The LED in the key lights and the indication of the unit (◁) is switched. At this time the resolution is automatically set to 0.1 Hz. In addition, the OFFSET value that was set prior to selecting the high resolution measurement function is automatically switched if it is 20 MHz or less. If the set value is 20 MHz or more, the OFFSET value is cleared (see paragraph 3.6.1 for OFFSET).

(5) The resolution may be selected up to 1 mHz depending on the range of the frequency to be measured. Set the desired resolution using the RESOLUTION key. See paragraph 3.4.9 for the setting method and counting time.

(6) Set the SAMPLE RATE as required. The measurements may be repeated at the desired speed. See paragraph 3.4.10.

The frequency of the input signal is displayed in this status. If the frequency of the input signal is not displayed at all or if the following error message is displayed and the function cannot be set, the input signal may be out of the allowable range. Verify the input signal referring to paragraph 3.5.2.1.

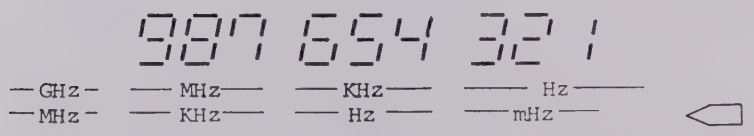


Note 1) The HI RESOL mode cannot be selected simultaneously with the BURST mode.

Note 2) A sharp fluctuation in the frequency of the input signal may result in an erroneous display or a prolonged counting time. Push the RESET key (9) in such cases.

[Example] The stabilized input frequency 987.6543 kHz is to be measured at a higher measuring resolution of 1 mHz following a normal measurement.

When the HI RESOL key (14), SHIFT key (10), and 1mHz / 3 key (15) are pushed in this order, the display will be as shown below:



(7) Push the HI RESOL key (14) to clear the HI RESOL mode to resume normal measurement. The LED in the key goes off and the indication of the unit is switched.
In this case, the resolution automatically returns to its original status prior to specifying the HI RESOL mode and the unit of the OFFSET value is automatically switched truncating any value under 10 mHz.

3.5.3 Measurement of Frequencies within the Range from 200 MHz to 18 GHz

By specifying AUTO mode, normal, continuous frequencies within the frequency range of INPUT 2 may be automatically measured. AUTO mode is automatically initialized when power is turned on.

3.5.3.1 Input Conditions

The allowable input conditions are as follows:

(1) Input frequency: 0.2 to 18 GHz

(2) Input level range: -22 to +10 dBm: 0.2 to 14 GHz
-15 to +10 dBm: 14 to 18 GHz

(3) Damage level: +20 dBm (The input circuit may be burned when a signal of +20 dBm or more is applied.)

Do not apply a signal of +20 dBm or more.

(4) FM tolerance: 25 MHzp-p: 0.2 to 0.5 GHz
50 MHzp-p: 0.5 to 18 GHz

(5)	AM tolerance:	Both the minimum and maximum levels must be within the input level range at a modulation factor of 40% or less.
(6)	Spurious:	The total sum of spurious should be 20 dB or more. However, 27 dB or more if the signal is 14 GHz or more and the spurious is 14 GHz or less.

3.5.3.2 Connecting the Input Signal

Apply the signal to be measured to the INPUT 2 connector (5) using the attached measuring coaxial cable.

The all-band coaxial cable should suffice for connecting the signal to be measured. Note that the loss of the cable cannot be ignored especially for high frequency.

Figure 3-5 shows the loss (typical values) of the attached coaxial cable (with N-type plugs on both ends) for the frequency.

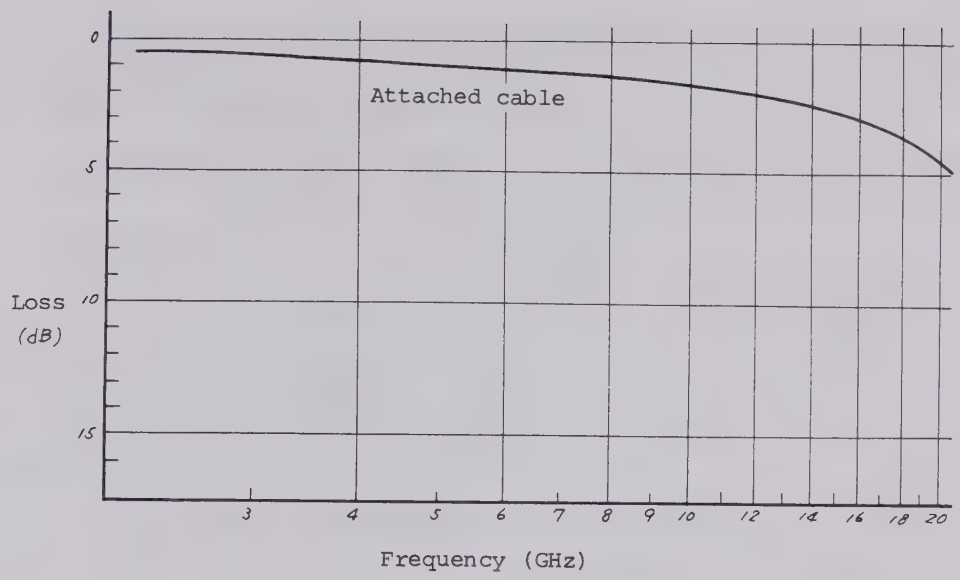


Fig. 3-5 Loss of Coaxial Cable (typical values)

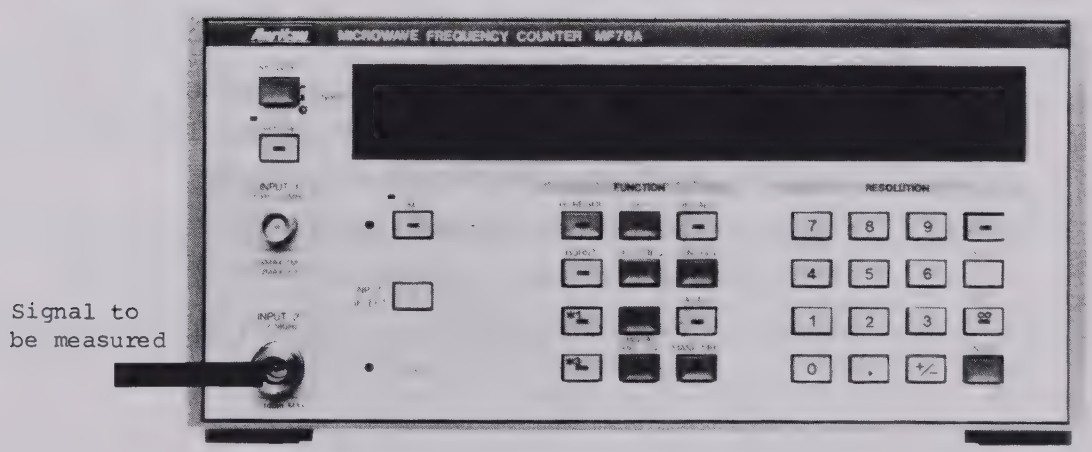


Fig. 3-6 Connection of INPUT 2

3.5.3.3 Settings

(1) Make the selection with the INPUT SELECT key (6) so that the LED on the INPUT 2 side lights.

(2) Push the AUTO key (14). If the LED in the MANUAL AMPL.DISC key (14) or the OFS FREQ key (14) is on, push the lit key.

The LED turns off and the key is cleared.

(3) Set the desired resolution using the RESOLUTION key. See paragraph 3.4.9 for the setting method.

(4) Set the SAMPLE RATE as required. See paragraph 3.4.10.

The frequency of the input signal is displayed in this status. If it is not displayed at all or is displayed incorrectly, verify the input signal referring to paragraph 3.5.1.

The acquisition time refers to the duration from when the RESET key (9) is pushed to when the counting operation begins. The acquisition time in AUTO mode varies depending on the input frequencies and input levels, but is generally 300 to 600 ms.

Note) A sharp fluctuation in the frequency of the input signal may result in an erroneous display. Push the RESET key (9) in such cases.

3.5.4 Measurement of Known Frequency

If the input frequency is known, the frequency may be manually set and measured within the range of ±40 MHz with the numeric keys by specifying MANUAL mode. Displayed frequency can also be specified as manual set value. This measuring method is effective where a miscount may occur due to the spurious signal. The acquisition time in MANUAL mode is approximately 300 ms.

> The input conditions and the connecting method of input signal are the same as those described in paragraph 3.5.3.1 and paragraph 3.5.3.2, respectively.

3.5.4.1 Setting the manual set value by means of numeric keys (15)

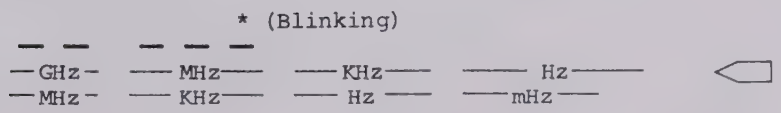
(1) Make the selection with the INPUT SELECT [ ] key (6) so that the LED on the INPUT 2 side lights.

(2) If the LED the [OFS FREQ] key is on, push the key to turn off the LED and clear the key.

(3) Set the desired measuring resolution referring to paragraph 3.4.9.

(4) Set the SAMPLE RATE as required. Measurements may be repeated at the desired speed. See paragraph 3.4.10.

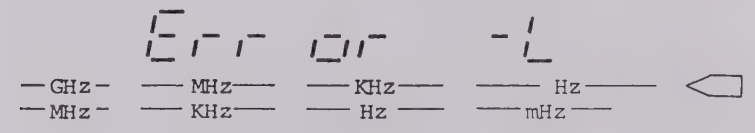
(5) When the [SET] key (14) and the [MANU MHz] key (14) are pushed in this order, the display will be as shown below, with the digit for the 1 MHz unit blinking to indicate the position of the first input data.



(6) Input the data of the manual set value using the numeric keys (15) ([·] to [9] keys). Up to five digits for the MHz unit can be set as the data input from the high order digit. Values consisting of five digits or more and operations of the [·] key and the [+/-] key will be ignored. To change data, push the RESET key (9) and then input the data again.

(7) When the ENTER key (15) is pushed, the set frequency is written into memory, the LED the MANU MHz key (14) lights, and the frequency can be measured in MANUAL mode.

If a numeric value outside the range from 150 to 23000 is input as data of the manual set value, the following error message is displayed on the display (12) for approximately 1.5 seconds and the status prior to the setting is resumed.

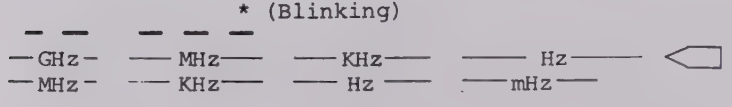


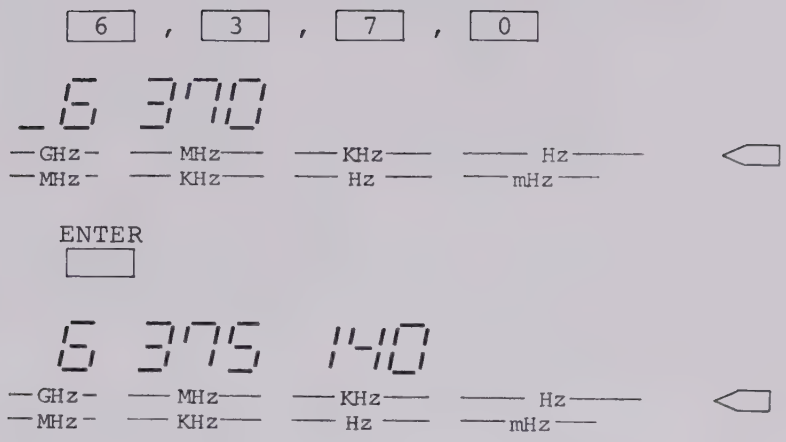
[Example] Measurement of the input frequency 6375.140 MHz in MANUAL mode with the following conditions:

RESOLUTION: 1 kHz

Manual set value: 6370 MHz

SET , MANU MHz





3.5.4.2 Setting Method of Manual Set Value by Inputting It from Measurement Value

In this setting method, manual set value is set from the status where the frequency has already been measured and displayed in either AUTO mode or MANUAL mode.

(1) Measure the frequency as explained in paragraph 3.5.3 or 3.5.4.1.

(2) Each time the MANU MHz key (14) is pushed, the immediately preceding measurement value is written into memory, the LED in the key lights, and the frequency can be measured in MANUAL mode.

FM wave with a maximum of 90 MHzp-p deviation may also be measured by using the center frequency as the manual set value.

3.5.4.3 Verification of Manual Set Value

Since the set value written into memory remains even after MANUAL mode has been cleared, it may be called for verification at any time.

When the RECALL key (14) and the MANU MHz key (14) are pushed in this order, the LEDs the keys light and the set value is called and displayed on the display (12).

Upon completion of verification, push the RECALL key (14). The LED in the key turns off, RECALL is cleared, and the original status is resumed.

3.5.4.4 Clearing MANUAL Mode

When the AUTO key (15) is pushed, the LED in the MANU MHz key (14) goes off, MANUAL mode is cleared, and AUTO mode is resumed.

The manual set value written into memory remains.

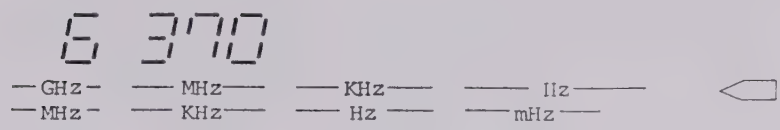
3.5.4.5 Switching to MANUAL Mode by Set Value Remaining in Memory

Manipulate the RECALL key (14) and the MANU MHz key (14) to call the set value.

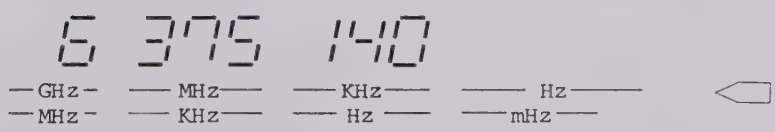
When the MANU MHz key (14) is pushed, RECALL is cleared, the previous set value is written into memory, and the frequency can be measured in MANUAL mode.

[Example] A request for checking a frequency in the 11 GHz band is received during measurement of the input frequency 6375.140 MHz with the manual set value of 6.37 GHz in MANUAL mode. The current measurement is interrupted to measure the requested frequency in AUTO mode. Then, the interrupted measurement is to be resumed using the previous set value.

RECALL , MANU MHz (Calling the set value)



MANU MHz (Resuming MANUAL mode measurement after verifying the set value)



3.5.5 Manual Amplitude Discriminating Function

When the level of the input signal is known, the signal can be measured by specifying MANUAL AMPL.DISC mode and manually setting the sensitivity with 0 to 7 (6 dB per step) codes by means of the numeric keys (15). An optimum value is automatically set in the usual AUTO or MANUAL mode, and this value may be held as the set value.

Code 0 represents the high input signal level (HIGH LEVEL) at which the sensitivity is the lowest, while code 7 represents the low input signal level (LOW LEVEL) at which the sensitivity is the highest.

> The input conditions and the connecting method of input signal are the same as those described in paragraph 3.5.3.1 and 3.5.3.2, respectively.

3.5.5.1 Inputting Method of Set Value by Means of Numeric Keys (15)

(1) Make the selection with the INPUT SELECT key (6) so that the LED on the INPUT 2 side lights.

(2) Set the desired measuring resolution using the RESOLUTION key. See paragraph 3.4.9 for the setting method.

(3) Set the SAMPLE RATE as required. Measurements can be repeated at the desired speed. See paragraph 3.4.10.

(4) The following display can be obtained by pushing the SET key (14) and the MANUAL AMPL.DISC key (14) in this order:

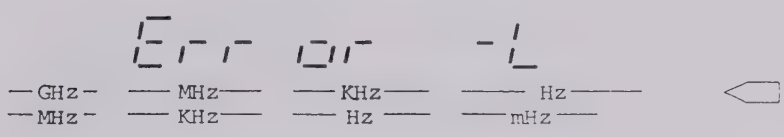
*(Blinking)

(INPUT LEVEL HIGH 0 - LOW 7)

(5) Input the data of the set value corresponding to the input signal level using the numeric keys (15) (0 to 7 keys). The data that can be set is a one digit code number from 0 to 7. The data can be changed by pushing the RESET key (9).

(6) When the ENTER key (15) is pushed, the set code number is written into memory, the LED in the MANUAL AMPL.DISC key (14) lights, and the measurement can be performed by means of the manual amplitude discriminating function.

If the level of the signal to be measured is inadequate for the set code number, the following error message is displayed on the display (12), in which case a code number corresponding to the signal level must be set again.



3.5.5.2 Holding Method of Optimum Value Set by Automatic Amplitude Discrimination

In this setting method, manual set value is set when the frequency has already been displayed before MANUAL AMPL.DISC mode is selected.

(1) Measure the frequency as explained in paragraph 3.5.3 or 3.5.4.

(2) When the MANUAL AMPL.DISC key (14) is pushed, the code number set to an optimum value is written into memory, the LED in the key lights, and the frequency can be measured by means of the manual amplitude discriminating function.

3.5.5.3 Verification of Set Value

When the RECALL key (14) and the MANUAL AMPL.DISC key (14) are pushed in this order, the LED in the key lights and the set value is called. When the RECALL key (14) is pushed upon completion of verification, the LED in the key turns off and the set value resumes its original status prior to being called.

3.5.5.4 Clearing Manual Amplitude Discriminating Function

When the MANUAL AMPL.DISC key (14) is pushed, MANUAL AMPL DISC mode is cleared and the measurement by means of the automatic amplitude discriminating function is resumed.

3.5.5.5 Setting MANUAL AMPL DISC Mode by Set Value Remaining in Memory

When the RECALL key (14), MANUAL AMPL DISC key (14), and MANUAL AMPL DISC key (14) are pushed in this order, the previous set value is written into memory, and the frequency can be measured in MANUAL AMPL DISC mode.

3.5.6 Measurement of Burst Signal of 100 kHz to 200 MHz

The carrier frequency of the intermittent signal whose amplitude has been modulated such as pulse modulation is measured. In BURST mode, counting begins when the signal arrives and the burst signal is measured.

BURST mode and HIGH RESOL mode cannot be used together.

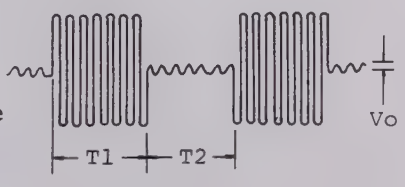
3.5.6.1 Input Conditions

The allowable input conditions are as follows:

(1) Carrier frequency: 100 kHz to 200 MHz

(2) Input waveform:

T1: Counting time + 200 µs or more
T2: 500 µs or more
Vo: 10 mV or less



(3) Input voltage range: 50 mV to 2 V rms

3.5.6.2 Connecting Input Signal

Connect the signal to be measured according to the connection method described in paragraph 3.5.1.2.

3.5.6.3 Settings

(1) Select the desired input impedance with the ■ 50Ω / □ 1MΩ key (7). The LED in the key is off when 50 Ω is selected and is on when 1 MΩ is selected.

(2) Make the selection with the INPUT SELECT key (6) so that the LED on the INPUT 1 side lights.

(3) If the LED in the HI RESOL key (14) or the OFS FREQ key (14) is on, push the lit key. The LED turns off and the key is cleared.

(4) Set the measuring resolution corresponding to the signal to be measured with the RESOLUTION key. See paragraph 3.4.9 for the setting method and counting time.

(5) Set the SAMPLE RATE as required. Measurement may be repeated at the desired speed. See paragraph 3.4.10.

(6) Push the BURST key (14). The LED in the key lights and the burst signal can be measured.

The carrier frequency of the intermittent signal to be measured is displayed in this status. If it is not displayed at all or if it is not displayed correctly, verify the input signal or the setting of resolution as explained in paragraph 3.5.6.1.

<u>BURST mode can be used only for measuring the carrier frequency, not the frequency of the modulated signal.</u>

3.5.6.4 Clearing Burst Mode

Push the BURST key (14). The LED in the key turns off, BURST mode is cleared, and normal measurement is resumed.

3.5.7 Measurement of Burst Signal of 200 MHz to 18 GHz

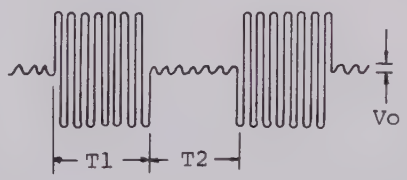
The carrier frequency of the amplitude modulated such as pulse modulated intermittent signal is measured.

3.5.7.1 Input Conditions

The allowable input conditions are as follows:

(1) Carrier frequency: 200 MHz to 18 GHz

(2) Input waveform:



T1: Counting time + 5 ms or more
T2: 5 ms or more
Vo: 5 mV or less

(3) Input level range:
-22 to +10 dBm: 0.2 to 14 GHz
-15 to +10 dBm: 14 to 18 GHz

3.5.7.2 Connecting Input Signal

Connect the signal to be measured as explained in paragraph 3.5.3.2.

3.5.7.3 Settings

(1) Make the selection with the INPUT SELECT key (6) so that the LED on the INPUT 2 side lights.

(2) If the LED in the OFS FREQ key (14) is on, push the lit key. The LED turns off and the key is cleared.

(3) Set the measuring resolution corresponding to the signal to be measured with the RESOLUTION key. See paragraph 3.4.9 for the setting method and counting time.

(4) Set the SAMPLE RATE as required. Measurements can be repeated at the desired speed. See paragraph 3.4.10.

(5) Set the MANUAL AMPL DISC mode corresponding to the carrier signal level. See paragraph 3.5.5.1.

(6) Set MANUAL mode within the range of ±40 MHz of the carrier signal frequency. See paragraph 3.5.4.1.

(7) Push the BURST key (14). The LED in the key lights and the burst signal can be measured.

The carrier frequency of the intermittent signal to be measured is displayed in this status. If it is not displayed at all or if it is not displayed correctly, verify the input signal conditions given in paragraph 3.5.7.1 and the settings of (3), (5), and (6) of paragraph 3.5.7.3.

This BURST mode is used only for measurement of the carrier frequency, not the frequency of the modulated signal.

3.5.7.4 Clearing Burst Mode

When the BURST key (14) is pushed, the LED in the key turns off and BURST mode is cleared. Note that both MANUAL mode and MANUAL AMPL DISC mode

remain specified. To return to AUTO mode, push the AUTO key (14) and the MANUAL AMPL DISC key (14) to clear them.

3.6 OPERATION OF ARITHMETIC DISPLAY FUNCTION

The following three types of arithmetic display functions can be combined with any measurement mode (paragraph 3.5):

(1) +OFFSET mode: Measurement value + set value

(2) -OFFSET mode: Measurement value - set value

(3) ppm mode : 10^6 x (measurement value - set value)/ set value

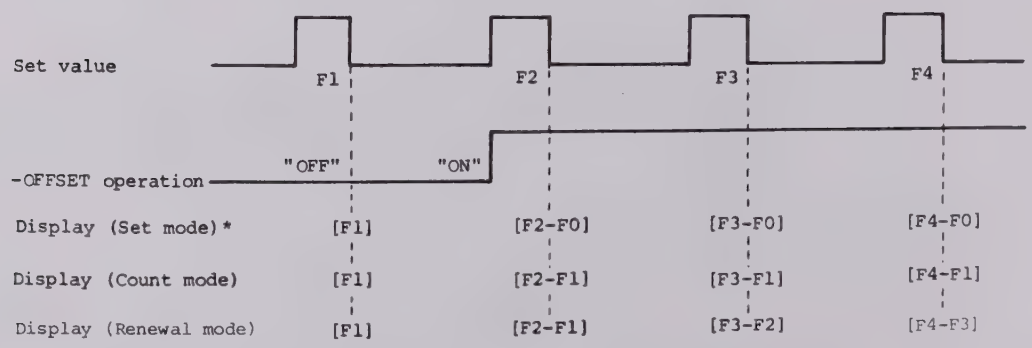
The data of the set value may be set using one of the following three methods:

(a) Set mode : Data is input from numeric keys

(b) Count mode : Measurement result is set as data

(c) Renewal mode: Measurement result is set as data, and data is renewed or changed with each new measurement

An example of arithmetic display in -OFFSET mode using the above three setting methods is shown in Fig. 3-7.



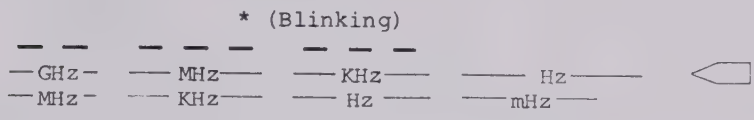
* When F0 is set as data from the keyboard.

Fig. 3-7 Arithmetic Display of -OFFSET Operation

3.6.1 OFFSET Mode

(1) Set mode (Data is input from numeric keys.)

When the SET key and the OFS FREQ key are pushed in this order, ▬ is displayed in correspondence to the set measuring resolution (the status shown below is for 1 kHz resolution).



Input the sign and data of the offset set value using the numeric keys (0 to 9 keys).

Up to five digits above and 7 digits below the decimal point for the MHz unit can be set as the data and the data is input from the high order digit. A numeric value exceeding the specified digits and the second and following decimal point operations will be ignored.

In -OFFSET mode, the +/- key (15) is pushed to set minus sign. In +OFFSET mode, the plus sign is set without the sign operation.

To change the data, push the RESET key (9) and then input the data again. A sign may be input to any position before or after a numeric value. A sign may be changed by pushing the +/- key again.

When the ENTER key (15) is pushed, the set data is written into memory.

Note) The data of the offset set value may be set up to the digit under the measuring resolution. However, since the arithmetic display is not performed, an erroneous

measurement may result. In this case, the resolution must be the set value or greater.

[Example 1] For setting 123.45 MHz as the set value in +OFFSET mode

SET , OFS FREQ , [1] , [2] , [3] , [·] ,

[4] , [5] , ENTER

[Example 2] For setting 8.765 MHz as the set value in -OFFSET mode

SET , OFS FREQ , [+/-] , [8] , [·] ,

[7] , [6] , [5] , ENTER

[Example 3] For setting 50 kHz as the set value in -OFFSET mode

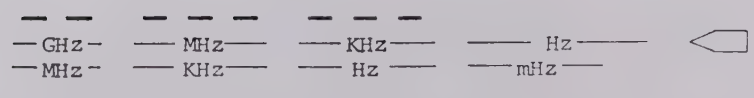
SET , OFS FREQ , [·] , [0] , [5] ,

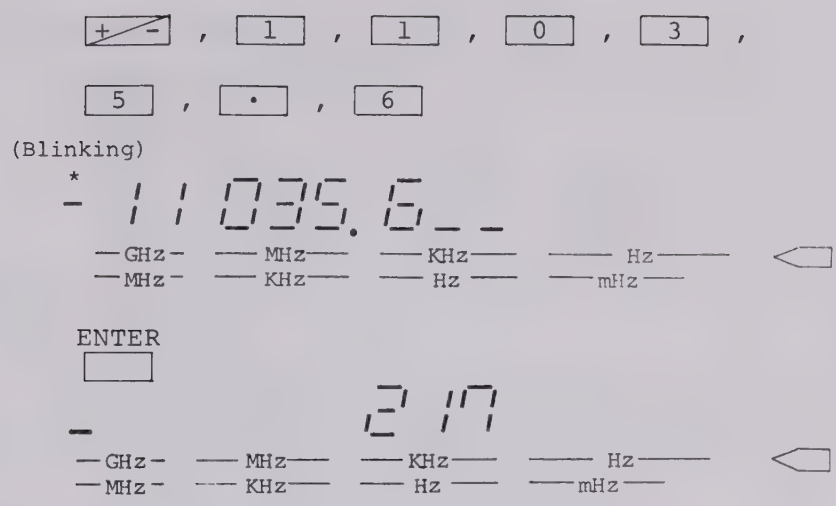
[+/-] , ENTER

[Example 4] For measuring the input frequency (11035.383 MHz) in -OFFSET mode with the data set to 11035.6 MHz when the resolution is set to 1 kHz.

SET , OFS FREQ

* (Blinking)





(2) Count mode (Measured value is set as the data.)

When the OFS FREQ key (14) is pushed, the LED in the key blinks and the measured value is displayed on the display (12).

The ENTER key (15) must be pushed immediately afterwards to set +OFFSET mode. To set -OFFSET mode, push the +/- key (15) and the ENTER key (15) in this order. The measured value displayed on the display (12) prior to pushing the ENTER key (15) is written into memory, the LED in the OFS FREQ key (14) lights, and the frequency can be measured in OFFSET mode.

This count mode cannot be specified when the instrument is operating in OFFSET mode. In such cases, the count mode must be specified after OFFSET mode has been cleared as explained in paragraph 3.6.1 (4).

[Example 1] For displaying the difference between one of the measured value as the reference and other measured values.

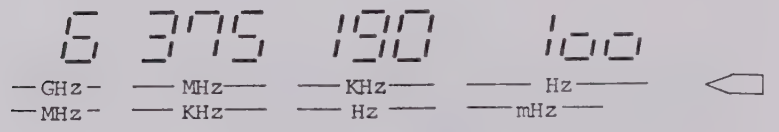
OFS FREQ , +/- , ENTER

[Example 2] The current -OFFSET mode operation is to be continued with the set value changed to the current measured value.

OFS FREQ , OFS FREQ , +/- , ENTER

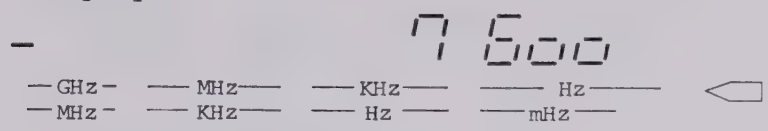
[Example 3] For measuring the frequency drift in the 6 GHz band with the resolution set to 100 Hz.
First, set the resolution to 100 Hz, then set -OFFSET mode based on a specific measured value (6375.190 MHz).

SHIFT , 100 Hz 5 (Resolution is set to 100 Hz and the initial value is measured.)

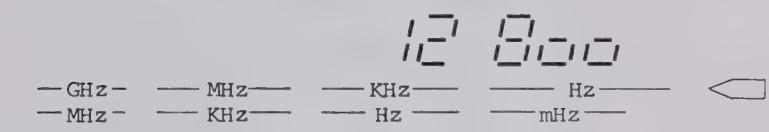


OFS FREQ , +/- , ENTER (-OFFSET mode is set using the initial value as the set value.)

(If the measured value is 6375.1825 MHz, the difference between the initial value is displayed.)



(If the measured value of the next measurement is 6375.2029 MHz, the difference between the initial value is displayed.)



(3) Renewal mode (The set data is renewed or changed with each new measurement.)

Update mode may be set from either of the following statuses:

(1) Renewal mode is set simultaneously with OFFSET mode from an ordinary operation.

(2) Renewal mode is set during an operation in OFFSET mode.

Both the set mode and count mode may be set in the case of (1).

When this Renewal mode is set, the LED in the OFS FREQ [▬] key (14) must be turned off when the set value is updated. Therefore, the LED is caused to blink by repeated measurements.

(A) Setting Renewal mode by set mode (The first set data is input with numeric keys.)

+OFFSET Renewal mode:

SET , OFS FREQ , CONTROL , x ..... x , ENTER

-OFFSET Renewal mode:

SET , OFS FREQ , CONTROL , +/- , x .....

x , ENTER

The key operations are the same as those explained in paragraph 3.6.1 (1), except that the CONTROL key (14) is pushed immediately following the OFS FREQ key (14).

(B) Setting Renewal mode by count mode (The measured value is used as the first set data.)

+OFFSET Renewal mode:

OFS FREQ , CONTROL , ENTER

-OFFSET Renewal mode:

OFS FREQ , CONTROL , +/- , ENTER

(C) Setting Renewal mode during OFFSET operation

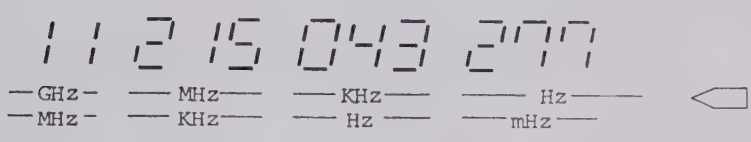
Pushing the OFS FREQ key (14) immediately following the CONTROL key (14) switches the mode to Renewal mode.

[Example] For measuring the frequency drift (altered width) at 30 minute intervals with the resolution set to 1 Hz for the purpose of checking the long-term stability of the signal to be measured in 11 GHz band. First, set the measuring resolution to 1 Hz. Then, set the sample rate to 30 minutes, and the -OFFSET Renewal mode.

SHIFT [ ] , 1 Hz [3] (Resolution is set to 1 Hz.)

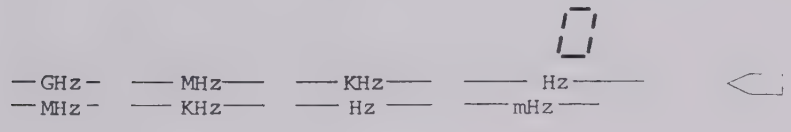
SET [ ] , SAMPLE RATE [ ] , [3] , [0] , ENTER [ ]

(Set the sample rate to 30 minutes and measure the frequency of the signal to be measured.)

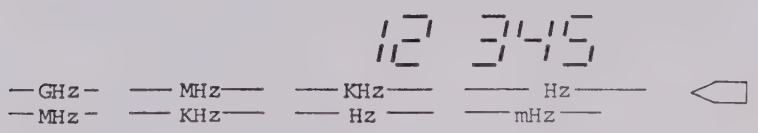


OFS FREQ [ ] , CONTROL [ ] , [+/-] , ENTER [ ]

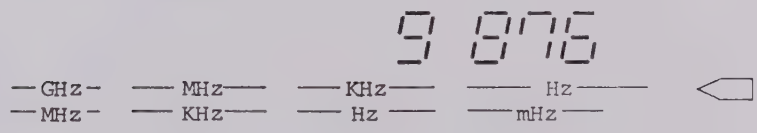
(-OFFSET Renewal mode is set using the measured value as the initial set value. The first measurement is performed immediately after this setting. Measurements are then performed every 30 minutes. If the measured result is the same as the measured value when the sample rate is set, difference 0 is displayed.)



(If the measured result 30 minutes later is 11215.055622 MHz, the difference between the first measured value is displayed.)



(If the measurement result of the third measurement (30 minutes later) is 11215.045746 MHz, the difference between the second measured value is displayed.)



(4) Altering and Clearing OFFSET Mode

(A) +/- switching of OFFSET mode

To switch -OFFSET to +OFFSET, and vice versa, during an OFFSET mode operation, push the [+/-] key (15). The sign of the set value is then changed and the mode is switched.

(B) Clearing OFFSET Renewal mode

To stop updating the set value and to continue the measurement in OFFSET mode, push the OFS FREQ [▭] key (14). An operation is performed using the measured value prior to pushing the key as the set data. When the OFS FREQ [▬] key (14) is pushed again, the LED in the key

turns off, the operation is cleared, and the normal measurement is resumed.

(C) Clearing OFFSET mode

Push the OFS FREQ key (14) to clear the OFFSET mode to return to the normal measurement. When the key is pushed, the LED in the key turns off and the mode is switched. In this case, the set value is not cleared but remains in memory.

(5) Verification of set value of OFFSET mode

The set value of the OFFSET mode may be called and verified at any time.

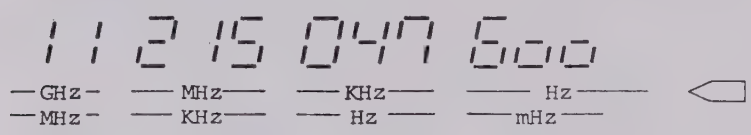
When the RECALL key (14) and the OFS FREQ key (14) are pushed in this order, the LED in the key lights and the set value is called and displayed. When the RECALL key (14) is pushed, the LED in the key turns off, the call is cleared, and the status prior to the calling of the set value is resumed.

(6) Switching to OFFSET mode by the set value remaining in memory

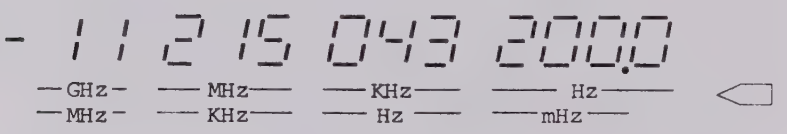
Push the RECALL key (14) and the OFS FREQ key (14) in this order to call the set value. When the OFS FREQ key (14) is pushed, the call is cleared and a measurement may be performed in OFFSET mode with the set value remaining in memory.

[Example] For clearing the OFFSET mode to verify the frequency being measured during an -OFFSET mode operation and for resuming the -OFFSET mode measurement with the previous set value.

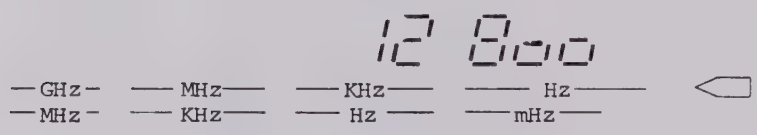
OFS FREQ (The OFFSET mode is cleared and the frequency being measured is displayed.)



RECALL , OFS FREQ (The previous set value remaining in memory is called.)



OFS FREQ (The measurement in -OFFSET mode is resumed.)



3.6.2 Parts Per Million (ppm) Mode

The following methods are available for setting the parts per million (ppm) mode:

1 Setting the ppm mode by inputting the set data with the numeric keys during a normal measurement operation.

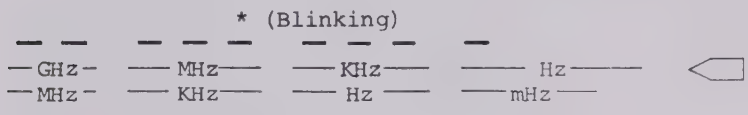
2 Setting the ppm mode using the measured value as the set data during a normal measurement operation.

3 Setting the ppm mode during a -OFFSET mode operation.

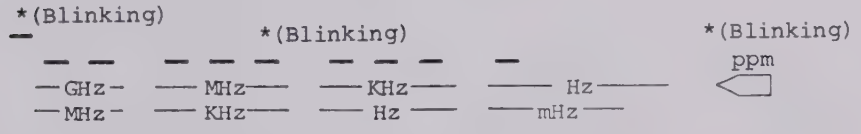
When the ppm mode is set, "ppm" is displayed on the display (12) to show that the unit of display is not frequency (GHz, MHz, kHz, Hz) but ppm (10^{-6}). The display may vary significantly for each measurement when RESOLUTION is set in the range from 1 kHz to 1 MHz. Because in the low frequency measurement with large resolution, percentage of the ±1 count error is high. Set the RESOLUTION within the range from 0.1 Hz to 100 Hz if the frequency to be measured is low.
The ppm mode may be combined with the Renewal mode.

(1) Set mode (The set data is input with numeric keys.)

When the [SET] key (14) and the [OFS FREQ] key (14) are pushed in this order, — is displayed in correspondence with the already set resolution (100 Hz in the example shown below) as follows:



Push the [SHIFT] key (10) and the [ppm +/-] key (15) in this order to specify the ppm mode. The unit of "ppm" is displayed and — blinks to indicate the minus data.



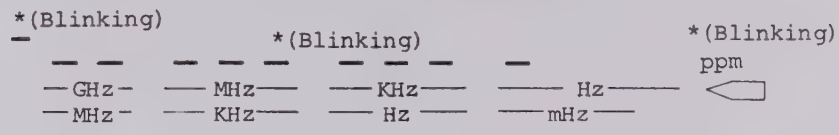
Input the set value (minus data) with the numeric keys (15) ([0] to [9] keys). The data that can be set is the same as for OFFSET mode. That is, up to five digits above and seven digits below the decimal point for the MHz unit, and data is input from the high order digits. Any numeric

value and sign exceeding the specified digits and the second and subsequent decimal point operations will be ignored.

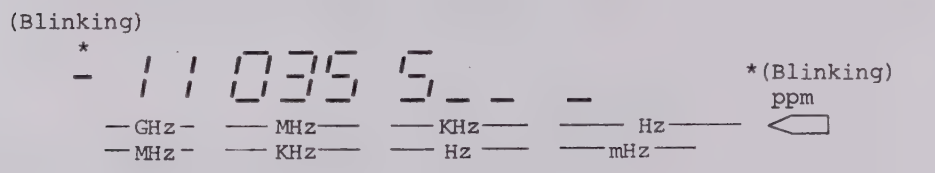
To change data, push the RESET key (9) and then input the data again. When the ENTER key (15) is pushed, the set data is written into memory and the ppm mode operation is performed.

[Example] For displaying ppm with resolution set to 100 Hz and data set to 11035.5 MHz.

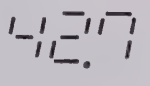
SET , OFS FREQ , SHIFT , ppm (+/-)



1 , 1 , 0 , 3 , 5 , . , 5



ENTER (The following display is obtained if the measured value is 11035.9713 MHz.)



(2) Count mode (The measurement value is used as the data.)

When the OFS FREQ key (14) is pushed, the LED in the key blinks and the measurement value is displayed on the display (12). Then, push the

SHIFT key (10) and the ppm key (15) in this order to specify ppm mode. When the ENTER key (15) is pushed, the displayed measured value is written into memory and measurements in ppm mode can be performed.

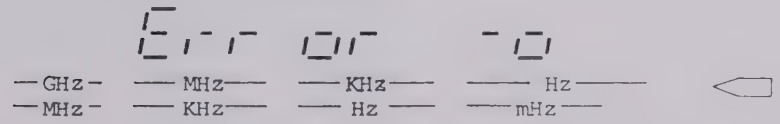
The set data automatically becomes minus data when ppm mode is specified. ppm mode setting can not be made by count mode during an OFFSET mode operation. In such cases, clear the OFFSET mode as explained in paragraph 3.6.1 (4) and then set the count mode.

[Example] For displaying the subsequent frequency change based on the current measured value. Ppm can be displayed by pushing the OFS FREQ key, SHIFT key, ppm key, and ENTER key in this order.

(3) Setting ppm mode from -OFFSET mode

To set ppm mode from a -OFFSET mode operation, push the SHIFT key (10) and the ppm key (15) in this order. Only the display is switched to ppm mode under the same conditions.

Note) The ppm mode cannot be set in the +OFFSET mode. If the ppm mode is specified in the +OFFSET mode, the following error message is displayed on the display (12). In this case, the ppm mode must be set after changing the +OFFSET mode to the -OFFSET mode by pushing the +/- key (15).



(4) Setting ppm mode from Renewal mode

Using the set mode: SET , OFS FREQ , CONTROL ,
SHIFT , ppm , x .....
x , ENTER

Using the count mode: OFS FREQ , CONTROL , SHIFT ,
ppm , ENTER

Setting the Renewal mode during a ppm mode operation: CONTROL , OFS FREQ

When this Renewal mode is set, the LED in the key blinks when measurements are repeated as in the OFFSET mode.

(5) Changing and clearing ppm mode

(A) Switching ppm mode to -OFFSET mode

When the ppm key (15) is pushed during a ppm mode operation, the ppm mode is cleared and -OFFSET mode operation begins.

(B) Clearing Renewal of ppm mode

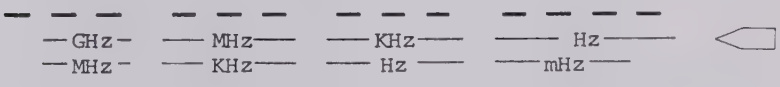
To stop updating the set value and to continue ppm mode operation, push the OFS FREQ key (14). The operation begins using the measured value immediately before the key was pushed as the set data. When the OFS FREQ key (14) is pushed again, the LED within the key turns off, ppm mode is cleared, and normal measurement is resumed.

(C) Clearing ppm mode

To clear the ppm mode and resume normal measurement, push the OFS FREQ key (14), the LED in the key turns off and the mode is switched. In this case, the set value is not cleared but retained in memory.

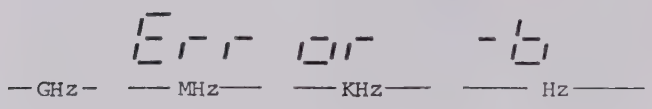
3.6.3 Overflow by Arithmetic Display Function

If the arithmetic result exceeds 12 digits due to the relationship between the measurement value and the set data when the arithmetic display function is used, the overflow is displayed as shown below. The arithmetic display function should be used so that the arithmetic result does not exceed 12 digits, carefully verifying the measured value or the set value.



3.7 ERROR MESSAGES

(1) The instrument executes a self-diagnosis of RAM and ROM immediately after the power is turned on. If an error is detected, an error message is displayed, as shown below, and the display (12) will not be checked or initialized. Since repair is required, contact Anritsu or its nearest agent.



(2) Limit error

If the set value input from the keyboard is outside the range of the specification, or if the condition of the signal to be measured is not suitable for the input set value, an error message is displayed as shown below. Verify the range of the set value or the condition of the signal to be measured, and reinput from the keyboard.

The error message above is displayed in any of the following cases:

(a) When data less than 150 MHz or more than 23 GHz is input during a MANUAL mode operation.

(b) When a high-level measurement code (codes 0 to 4) is set for measuring a low-level signal in the MANUAL AMPL.DISC mode.

(c) When 20 ms or less is input as the SAMPLE RATE.

(3) Order error

If an attempt is made from the keyboard to select a function that cannot be requested under the current operating condition, or if the keyboard is operated without conforming to the specifications, an error message is displayed as shown below. In this case, the selected keys are cleared, and the instrument returns to the previous operating status. Refer to the SECTION 3 for details on correct keyboard operation.

The error message above is displayed in any of the following cases:

(a) When the ppm mode is specified during a +OFFSET mode operation.

(b) When the MANUAL AMPL.DISC or HI RESOL mode is specified during a CHECK operation.

(c) When the RECALL key is used to call the SAMPLE RATE set with the numeric keys.

(d) When the BURST mode is specified during a HI RESOL mode operation.

(e) When the HI RESOL mode is specified during a BURST mode operation.

SECTION 4

PRINCIPLES OF OPERATION

4.1 PRINCIPLES OF MEASUREMENT

Fig. 4-1 is a block diagram of the MF76A.

The term "frequency" here means "oscillation count per unit time".

The basic operating principle is called direct counting. In a frequency measurement, the main gate is opened for the period of an accurate unit time determined by the reference time signal generating circuit, the signals to be measured pass through the main gate, and the number of signals are counted by the counting circuit and displayed.

This instrument uses the direct counting method for 10 Hz to 200 MHz in the INPUT 1 connector.

The signal to be measured connected to the INPUT 1 connector is passed through the 50Ω/1MΩ input impedance switching circuit. It is then applied to the DIRECT AMP and Schmitt circuit. Here, the gain of the DIRECT AMP is controlled so that the input level to the Schmitt circuit is constant. This keeps the noise amplitude under the sensitivity level of the Schmitt circuit thus preventing any error in the count caused by noise, regardless of the amplitude of the input level.

The input signal is shaped and converted to pulse by the Schmitt circuit and output to the main gate. The main gate is opened for only the gate time generated by the reference time signal (based on the reference oscillator signal) to send the pulse to be measured to the COUNTER. The pulse count data obtained by the COUNTER is processed by the CPU and displayed on the display.

For a HI RESOL mode measurement, the reciprocal method is adopted to display the frequencies by calculating the measured value of period.

The pulse to be measured are sent to the DIVIDER, where they are divided within the range of 1/2 to $1/10^8$. This dividing factor is maintained at an optimum value by the CPU from the correspondence between the measuring resolution and the frequency of the signal to be measured. The main gate is opened for a predetermined period of the signal to be measured from the DIVIDER to send the 5 ns VCO signal that has been phase locked with the signal of the reference oscillator to the COUNTER. The period of time for which the main gate is opened can be obtained from the number of pulses from the COUNTER. The CPU calculates the number of pulses based on the dividing factor and displays the frequency.

The hetrodyne down converter method is adopted for the INPUT 2. Input signal is frequency converted, then counted and displayed.

When the signal to be measured is connected to the INPUT 2 connector, it is mixed with the N-order harmonic of VCO by the harmonic mixer, and the IF signal is obtained.

The VCO signal is phase locked with the reference frequency at 100 kHz intervals and its frequencies are controlled by the control signal from the CPU.

When the IF signal is obtained within the IF AMP band after sweeping the VCO frequency, the VCO frequency is fixed, and the IF signal is amplified by the IF AMP and counted directly as it passes through the main gate.

Since the harmonic number (N) is determined by the difference in the IF signal caused by the difference of the VCO signal. The difference in the IF signal is supplied to and calculated by the CPU.

The relationship among the frequencies of the signal to be measured Fx, VCO signal F_1, and IF signal F_2 is as shown below:

$$Fx = N.F_1 \pm F_2$$

$$Fx = NF3 \pm F4$$

$$N = \frac{|F_4 - F_2|}{F_1 - F_3}$$

Therefore, the signal to be measured Fx is processed and displayed by the CPU based on the above expression after measuring the IF signal F_2.

In MANUAL mode measurement, the VCO frequency can be fixed directly so that the IF frequency is within the IF AMP band based on the set value when the signal to be measured is input. This is a queued status at the frequency at which the MANUAL mode was set. By using the memory installed as a peripheral device of the CPU, the counted value can be added or subtracted, and the ppm can be calculated and displayed by the CPU.

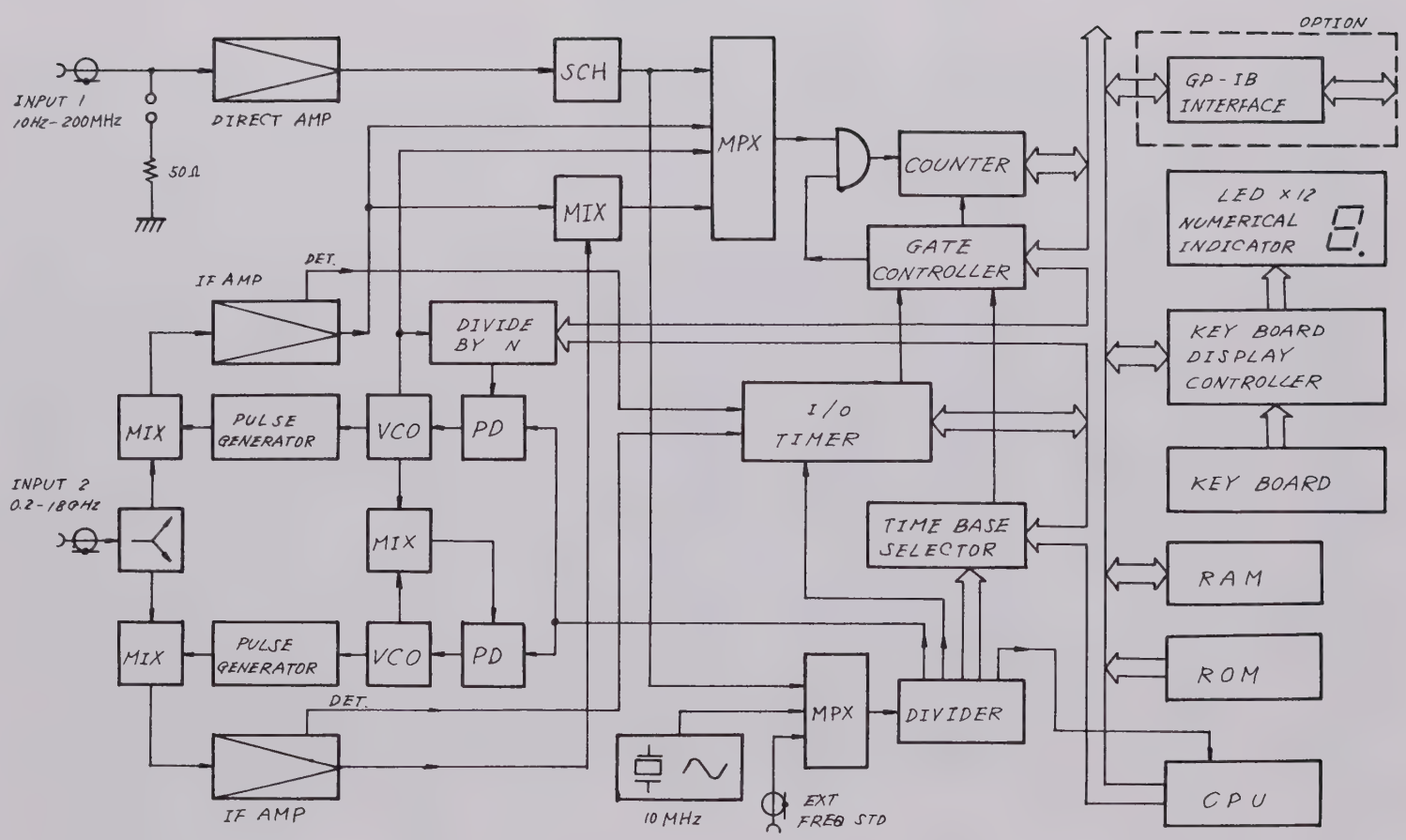


Fig. 4-1 MF76A Block Diagram

4.2 ACCURACY OF FREQUENCY MEASUREMENT

As described earlier, a frequency measurement means that the main gate is opened for precisely the predetermined period of time to let the signal to be measured pass through and that the frequencies of the signal are counted.

However, the signal to be measured is not always synchronized with the reference time signal opening the gate. Therefore, as is apparent from Fig. 4-2, the number of signals may be one count more or one count less depending on the relative position.

This is described as ±1 count in the accuracy.

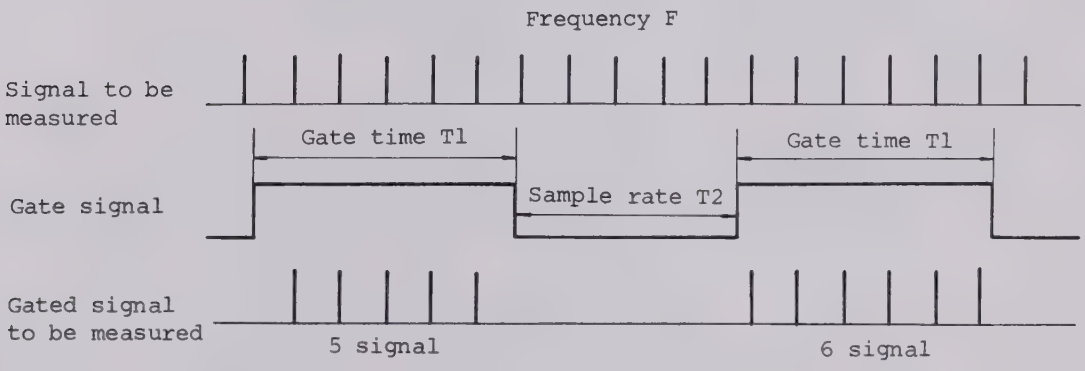


Fig. 4-2 One Count Error

The ±1 count may be expressed as follows by converting it into a value relative to the displayed value:

$$\text{Measurement accuracy} = \text{reference time accuracy} \pm \frac{1}{F \times T_1}$$

4.3 TRIGGER ERROR

The reciprocal method is adopted for a HI RESOL mode measurement. The frequency is obtained by calculating the measured value of period and is displayed.

Since the signal to be measured is used as the gate time in period measurements, even a very small noise component may cause a fluctuation in the counting time resulting in an error, unlike the frequency measurement. As shown in Fig. 4-3, when the gate is opened/closed by the noise signal at the trigger point, the gate time is lengthened or shortened by ΔT.

The relationship as shown below holds when the ideal signal tilt (V/sec) at the trigger level is S and the peak value of the noise signal is E_N:

$$S = \frac{E_N}{\Delta T}$$

Therefore, the maximum error in the measuring period due to noise is $2\Delta T$, and the trigger error is

$$\frac{2\Delta T}{T} = \frac{2\ E_N\ \text{(peak value)}}{TS}$$

when the measuring period is T. For example, the trigger error of the sine wave whose amplitude is Es is as shown below:

$$\frac{2\Delta T}{T} = \frac{E_N\ \text{(peak value)}}{\pi Es\ \text{(amplitude value)}}$$

It can be seen from the above expression that the trigger error in period measurement is inversely proportional to S/N of the input signal. For example, if a signal with 40 dB S/N is measured, a maximum of approximately 0.3% of the trigger error will occur. The waveform with earlier rise time at its trigger position has a smaller trigger error even at the same period. For example, the accuracy

of period measurement of a square wave is higher than that of a sine wave and the accuracy can be improved by ten times if ten period measurements are made with the same waveform triggered at the same point. That is, ten period measurements of a signal with 40 dB S/N produce a maximum of approximately 0.03% of the trigger error.

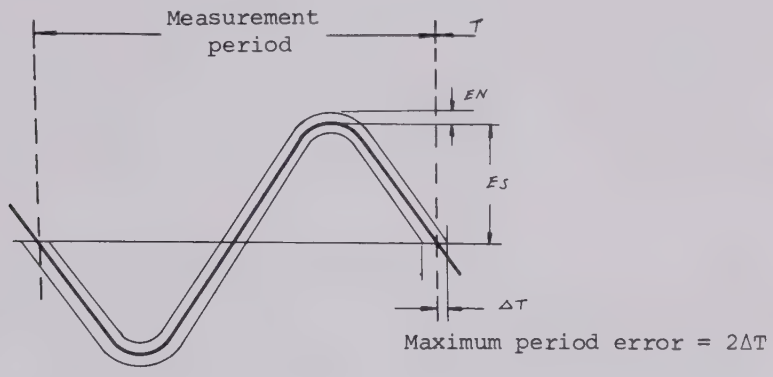


Fig. 4-3 Trigger Error by Noises

SECTION 5

CALIBRATION

5.1 STORAGE

5.1.1 Storage Conditions

When the instrument will not be used for an extended period of time, it is recommended that it be stored in the storage trunk (optional accessory), or be covered with a vinyl cover and stored in a place with low humidity and relatively stable temperature.

5.1.2 Precautions on Use After Storage

Condensation may form of the instrument when it is brought into a normal or high temperature environment after it has been stored at a low temperature for an extended period of time. Do not use the instrument until it has dried thoroughly.

When using the instrument after lengthy storage, it is recommended that the reference oscillator be calibrated in accordance with paragraph 5.3 prior to any measurement.

5.2 EQUIPMENT REQUIRED FOR CALIBRATION

1) Frequency standard or standard radio receiver

2) Oscilloscope

5.3 CALIBRATION

One of the most important factors determining the accuracy of the frequency counter is the accuracy of the oscillation frequency from the internal reference oscillator that generates the reference time. Therefore, it is necessary to calibrate the reference oscillator periodically with a reference frequency whose accuracy is

guaranteed in order to maintain a high measurement accuracy.

Even if a reference oscillator with excellent stability is used, the accuracy of the measurement will not be greater than the calibrated accuracy if it has of a lower value. For example, if a reference oscillator with a high stability of 5×10^{-10}/day aging rate is calibrated by a signal whose accuracy is 5×10^{-8}, the measurement accuracy will not be better than 5×10^{-8}, even though the fluctuation in accuracy is as small as 5×10^{-10}/day. This kind of calibration method does not make the best use of the highly stable performance of 5×10^{-10}/day.

On the other hand, a high calibration accuracy is meaningless if the stability is poor.

Therefore, an effective calibration method requires that stability and accuracy of the reference oscillator be set at about the same level.

Calibration is performed as follows. Figure 5-1 shows the connections for calibration, and Figure 5-2 illustrates disassembly and assembly of the top cover.

(1) Supply the power to the counter for five hours or more in a room with a constant (normal) temperature to sufficiently warm it up.

(2) Connect the frequency standard or standard radio receiver having an accuracy higher than required and the oscilloscope as shown in Fig. 5-1.

(3) Apply the reference frequency standard to the external synchronous input of the oscilloscope.

(4) Apply the signal of the "FREQ STD 10 MHz OUT" (20) on the rear panel of this instrument to the vertical axis input of the oscilloscope.

(5) Adjust the oscilloscope so that the input waveform can be observed.

(6) If the waveform on the oscilloscope shifts to the left or right and cannot be synchronized, it implies that the frequency of the reference oscillator in this instrument does not agree with the reference frequency standard.

(7) Remove the top cover of this instrument and remove the cover of the frequency adjuster for the reference oscillator and turn the potentiometer inside, adjusting it so that the waveform on the oscilloscope does not shift to the left or right.

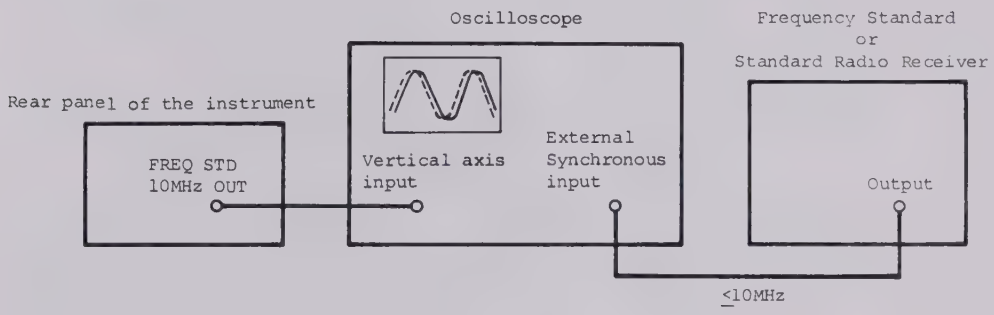
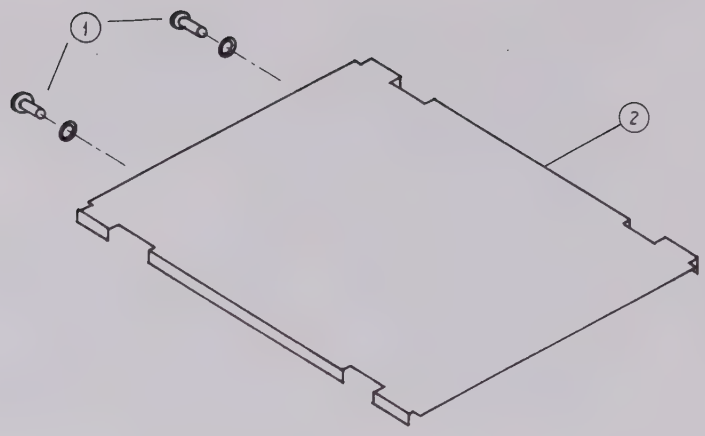
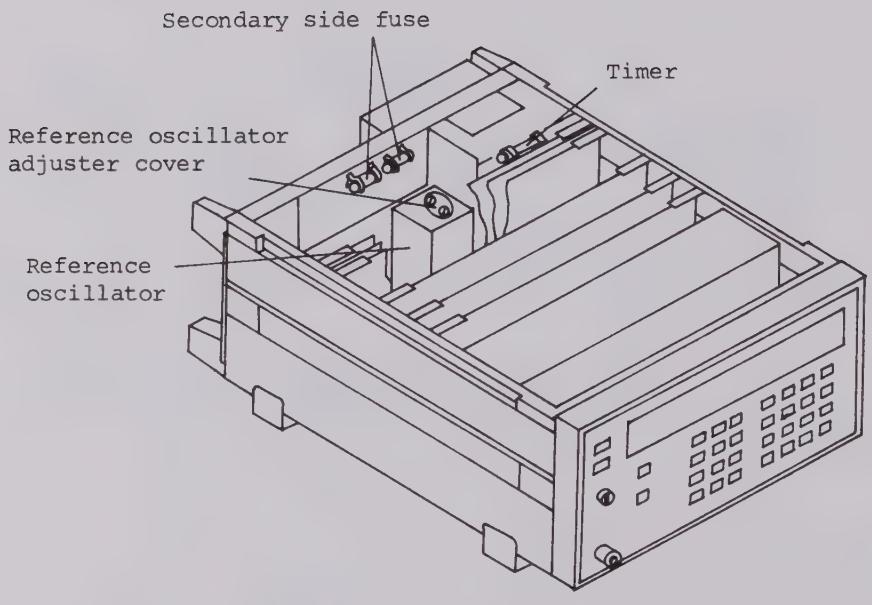


Fig. 5-1 Example of Connections for Calibrating the Reference Oscillator





Disassembly and assembly procedures

(1) Remove the two screws (1) and the top cover (2).

(2) The reference oscillator, secondary side fuses, and the timer inside the instrument are now visible.

(3) Assemble the top cover in reverse order.

Fig. 5-2 Disassembly and Assembly of Top Cover

SECTION 6

GPIB INTERFACE (OPTION 06)

6.1 GENERAL

The MF76A Microwave Frequency Counter can be connected to an IEEE Std 488-1978 interface bus (GPIB) by installing Option 06. This option has basic talk only mode and addressable mode functions, and allows the construction of the desired system, from a simple system consisting of devices having listen only function (printer, etc.) to a total measurement system that interfaces with external devices having controller and other functions.

In the addressable mode, complete remote control by an external controller is possible.

6.2 SPECIFICATIONS

Table 6-1 shows the option 06 specifications (function).

Table 6-1 MF76A GPIB Specifications

Item	Description
Interface functions	SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0
Talker function	Measurement data transmission.
Talk only function	Measurement data transmission.
Listener function	Measurement conditions control.
Device trigger function	Measurement initiation by reception of multi-line address command message GET.
Device clear function	Initialization by reception of multi-line universal command message DCL and multi-line address command message SDC.

Table 6-1 MF76A GPIB Specifications (Cont'd)

Item	Description
Service request (SRQ) and serial poll (SPMS) functions	Serial polling response when SRQ generated at end of measurement and listener FORMAT ERROR or COMBINATION ERROR occurs.

6.3 GPIB System Outline

The GPIB system electrically and mechanically standardizes the interface for devices having diverse functions, connects the devices to one bus line and transmits data among devices through this bus line.

The block diagram of the GPIB system is shown in Fig. 6-1.

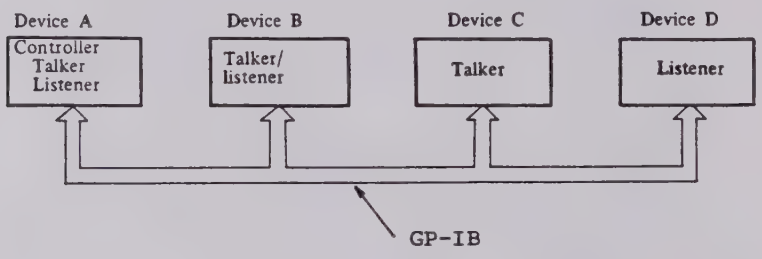


Fig. 6-1 GPIB System Block Diagram

In Fig. 6-1 four devices are connected as an example. However, this interface bus system can connect up to a maximum of 15 devices.

The functions of the devices can be classified into three groups with each device belonging to any group.

a) Controller

This controls the overall system. A computer or calculator generally has this function.
The controller is capable of specifying itself or

other devices as the listener and talker.
Two or more controllers may be attached to one bus system, but only one can be operated as the controller at one time.

b) Talker

This is a device that has been given the capability to send data to other devices. This function is enabled only when the device is specified as a talker. Two or more talkers cannot exist at the same time at one bus system.

c) Listener

This is a device that has been given the capability to receive data from the talker. This function is enabled only when the device has been specified as a listener. One bus system can contain multiple listeners.

The three system elements have been described above. However, the actual devices often have all these functions. For example, a calculator can be operated as controller, talker, and listener as different times.

6.3.1 Description of Bus Line

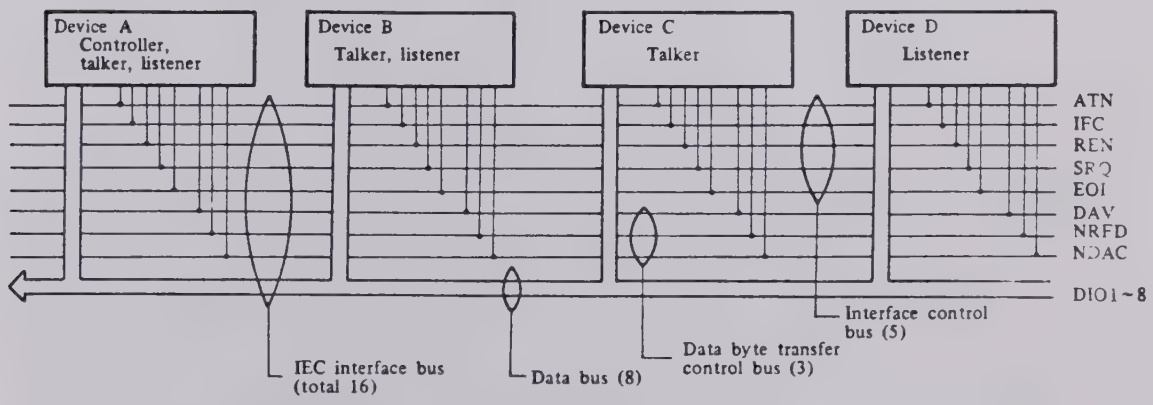


Fig. 6-2 Construction of Bus Line

As shown in Fig. 6-2, the bus line consists of 16 signal lines functionally divided into the following three buses:

1) Data bus (DIO1 to DIO8)

   This bus consists of 8 signal lines and is used to transfer data between devices and to send various commands from the controller to other devices. The data and command transfer format is bit parallel, byte serial.

2) Data byte transfer control bus (DAV, NRFD, NDAC)

   This bus consists of 3 signal lines and is used to send messages placed on the data bus by the talker to the listener.
   The process of sending data by means of these three signal lines is called 3 wire handshake.
   The role of each of the three signal lines is as follows:

   ° DAV (Data Valid)
     This line indicates that the data on the data bus are effective. This line is controlled by the controller or talker.

   ° NRFD (Not Ready For Data)
     This signal line indicates that the listener is not ready to receive the data on the data bus. This line is controlled by the listener.

   ° NDAC (Not Data Accepted)
     This line indicates that the listener has not accepted the data on the data bus. It is controlled by the listener.

3) Interface control bus (ATN, IFC, REN, SRQ, EOI)

   This bus consists of five signal lines and is concerned with control of the overall bus system.
   The operation of each signal line is given below.

° ATN (Attention)
This line controls the controller and discriminates the meaning of the data on the data bus. (Discriminates between command or address and data.)
When this line is TRUE, the data on the data bus are address or command and all the devices must receive data by participating in three wire handshake.
When this line is FALSE, the data on the data bus are general data and only the specified (addressed) devices participate in three wire handshake and transfer data. At this time, the other devices are irrelevant.

° IFC (Interface Clear)
This line sets the initial conditions and is controlled by the controller.

° REN (Remote Enable)
This line is controlled by the controller and is used to control whether the devices are remote or local in accordance with the other messages (commands).

° SRQ (Service Request)
This line is used when an interruption is generated for the controller. Each device controls this line.

° EQI (End Or Identify)
This line is used to indicate the end of transfer of several bytes of data. It is controlled by the talker.

6.3.2 Three Wire Handshake

As previously described, the three lines DAV, NRFD and NDAC are used to reliably transfer data and command

between devices. The relationship between these three lines and the devices is shown in Fig. 6-3 (Time chart) and Fig. 6-4 (Flow chart).

The GPIB bus logic and signal names will be described here as necessary precautions regarding Fig. 6-3 and Fig. 6-4. The GPIB bus is negative logic. That is, LOW level indicates that a signal is present. For example, when DAV (Data Valid) is LOW level, it indicates that the data to be transferred are on the bus line. However, on the 16 signal lines, NRFD (Not Ready For Data) and NDAC (Not Data Accepted) are functionally positive logic. When NRFD is HIGH level, for example, it indicates that the device is ready to accept data at RFD (Ready For Data). Therefore, if this is considered to be negative logic, it has the meaning of negation at RFD and becomes Not Ready For Data NRFD as the function of the line when LOS level.

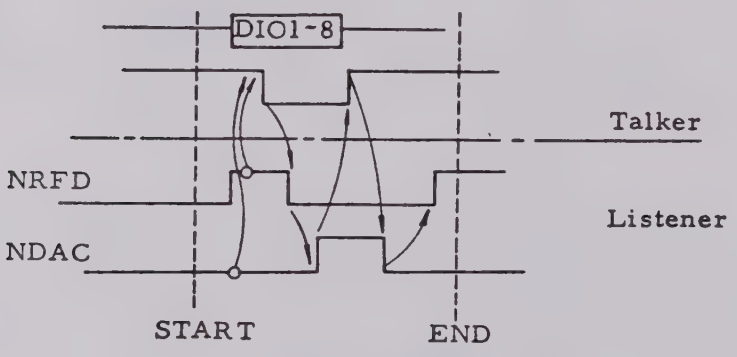
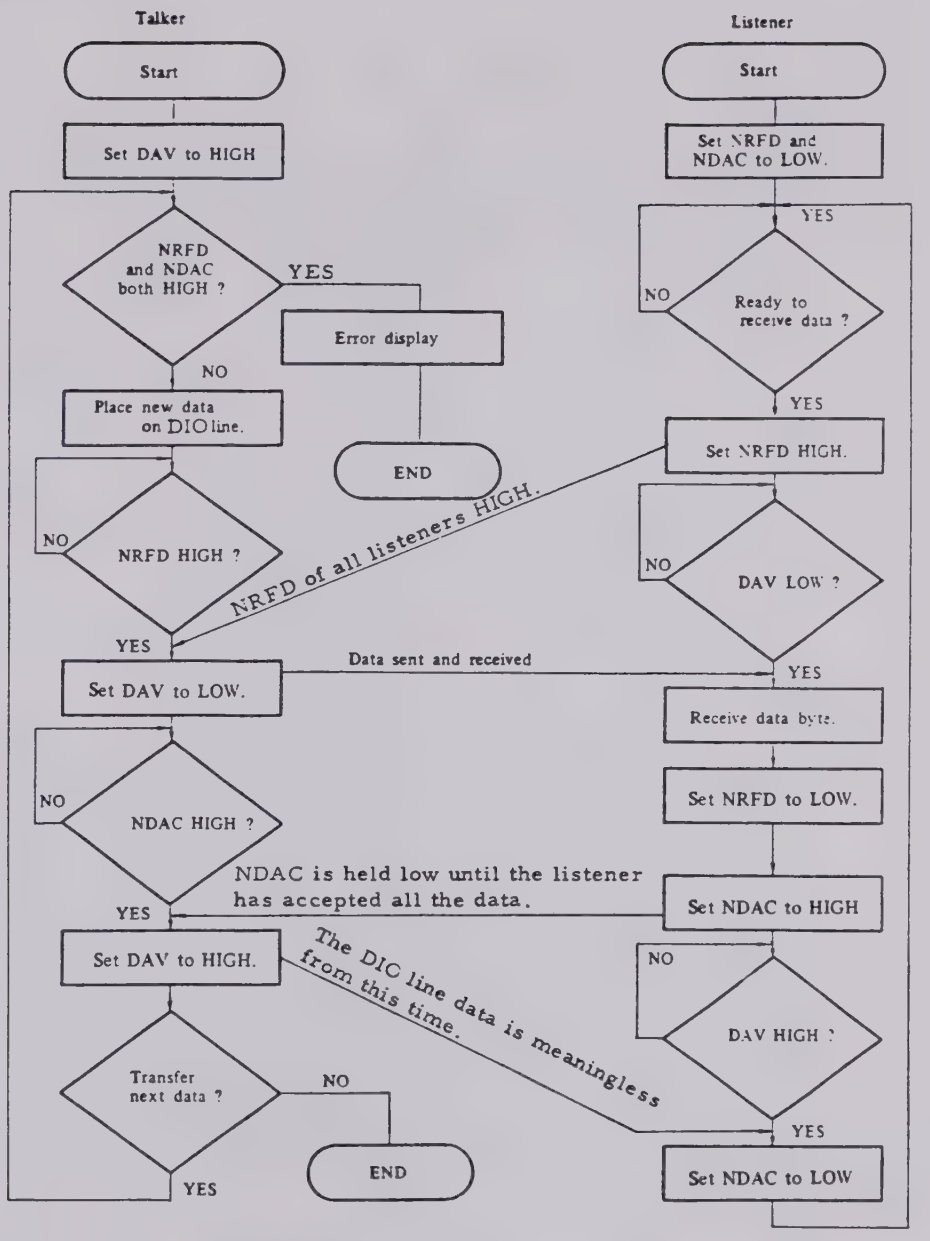


Fig. 6-3 Three Wire Handshake Time Chart



This handshake is performed one time, each time the talker sends data to the listener. DAV is controlled by the talker and NRFD and NDAC are controlled by the listener.

Fig. 6.4 Three Wire Handshake Flow Chart

6.4 OPERATING INSTRUCTIONS

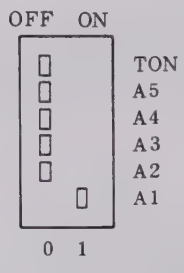
6.4.1 Address switch Setting

The devices connected to the GPIB are assigned a unique address. This address must be set. The address of each device is represented by a five bit (A5 - A1) binary number. If the set bit configuration and bits b5 - b1 of the address code sent from the control match, the combination of bits b7 and b6 designate the device a talker or a listener.

This MF76A is addressed by setting the address switch on the rear panel.

The address setting switches (A5 - A1) and the talk only (TON) switch form a single unit as shown in Fig. 6-5.

When the TON switch is set to ON, the talk only mode is selected and the MF76A is locked in the talker state regardless of the settings of switches A5 - A1. When the TON switch is set to OFF, the addressable mode is selected, and an arbitrary address within the range shown in Table 6-2 "ASCII code" (31 addresses corresponding to the decimal numbers 00 - 30) can be set with switches A5 - A1. The code at which all five bits are "1" (equivalent to the decimal number 31) is a special command (unlisten or untalk) which cancels the listener or talker specification for all the devices, and cannot be used.



In Fig. 6-5 the address switches are set to "00001". This corresponds to decimal "01" and sets the talk address "A" and listen address "!".

Fig. 6-5 Address Switches

Table 6-2 ASCII Code

ASCII code character		Address switches					5 bit decimal code
LISTEN	TALK	A5	A4	A3	A2	A1	
SP	@	0	0	0	0	0	00
!	A	0	0	0	0	1	01
"	B	0	0	0	1	0	02
#	C	0	0	0	1	1	03
$	D	0	0	1	0	0	04
%	E	0	0	1	0	1	05
&	F	0	0	1	1	0	06
'	G	0	0	1	1	1	07
(	H	0	1	0	0	0	08
)	I	0	1	0	0	1	09
*	J	0	1	0	1	0	10
+	K	0	1	0	1	1	11
,	L	0	1	1	0	0	12
-	M	0	1	1	0	1	13
.	N	0	1	1	1	0	14
/	O	0	1	1	1	1	15
0	P	1	0	0	0	0	16
1	Q	1	0	0	0	1	17
2	R	1	0	0	1	0	18
3	S	1	0	0	1	1	19
4	T	1	0	1	0	0	20
5	U	1	0	1	0	1	21
6	V	1	0	1	1	0	22
7	W	1	0	1	1	1	23
8	X	1	1	0	0	0	24
9	Y	1	1	0	0	1	25
:	Z	1	1	0	1	0	26
;	[	1	1	0	1	1	27
<	\	1	1	1	0	0	28
=	]	1	1	1	0	1	29
>	-	1	1	1	1	0	30

6.4.2 Device Connections

(1) Before connecting the devices (controller, peripheral devices, etc.) forming the GPIB system, check the status (preparations) and operation of each device as described in the pertinent instruction manuals.

(2) Up to 15 devices can connect to the GPIB system. However, the length of the connection cables is restricted as follows:

(a) The length per cable must not exceed 2 m.

(b) The overall cable length must not exceed 20 m.

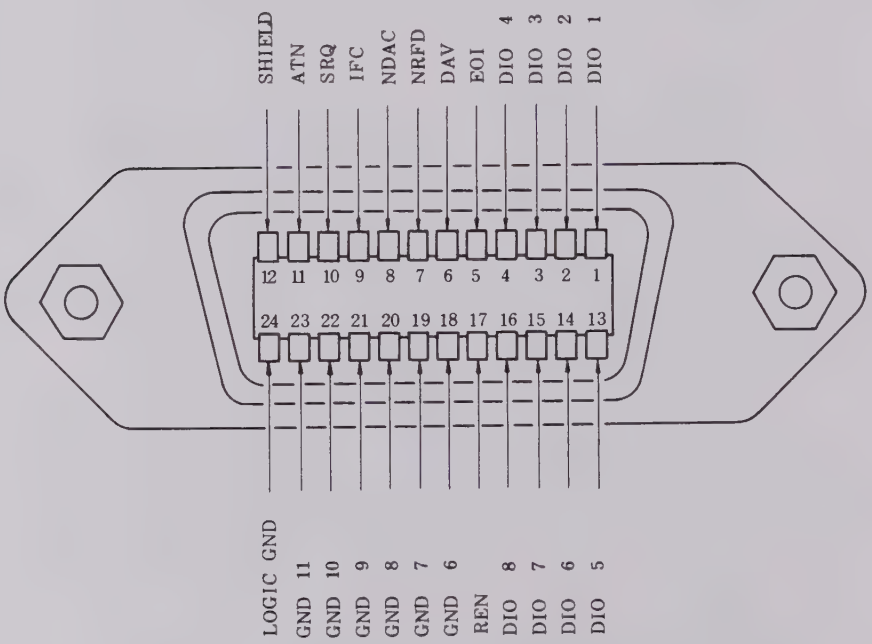


Fig. 6-6 GPIB Interface Connector Pins Arrangement

(3) When using the MF76A in the talk-only mode, always set the address mode of the opposite device to listen-only.

In this mode, the controller cannot be connected and operated simultaneously.

(4) Check the power supply conditions, grounding, and necessary setting conditions of each device in the GPIB system, then turn on the power to each device. If the power to one or more connected devices is not turned on, system operation is not guaranteed.

6.4.3 Control

(1) Remote and local switching function

When the REN line is low level (TRUE) and the listen address is set, the remote mode is selected. When this mode is set, the LED in the LOCAL REMOTE key lights.
The local mode is set when the REN line is high level (FALSE), or a GTL command (code X 0 0 0 0 0 0 1) is executed.
To switch the MF76A from the remote to the local mode, press the front panel LOCAL REMOTE key. However, the MF76A cannot be switched when in the local lockout state.

(2) Listener format

To control the various functions of the MF76A, designate it a listener, then give the program codes described below. Two or more functions can be set consecutively. To do this, enter a (,) or space (Δ) between the codes. This delimiter can be omitted at the end of the message of each code. End the message on one line by (CR)(LF) code.
When the MF76A is designated a listener, the LED in the front panel SET key lights.

(a) Service request generation mode: RQ [REQUEST ENABLE]

The MF76A has the following three service request functions:

(i) Service request when data is generated by end of measurement.

(ii) Service request when a program code error or a low, out of range, or other data specification format error occurs.

(iii) Service request when a combination error is generated by specification of a message for a combination of a non-existing function with an existing function. (See paragraph 6.4.3 (4).)

Each service request function can be set by program code (RQ0~RQ7). A one byte status is sent in reply to serial polling. The interrupt flag has the same configuration as the RQ code argument (0-7). A "1" in a certain bit indicates that interrupt correspond to each bit occurred. See paragraph 6.4.3 (5)(b) for the output status.

Code	Function
RQ0	Disable all requests (SRQ not generated).
RQ1	Enable only measurement end request.
RQ2	Enable only format error request.
RQ3	Enable measurement end and format error requests.
RQ4	Enable only combination error request.
RQ5	Enable measurement end and combination requests.
RQ6	Enable format error and combination error requests.
RQ7	Enable all requests (SRQ generated for all requests).

(b) Data terminator: DT [DATA TERMINATOR]
When the MF76A is addressed to talk, a delimiter code indicating the end of data output can be specified. When it is addressed to listen, all the data terminators can be received regardless of the specified DT code.

Code	Function
DT0	(CR) (LF ∧ END) (EOI line is made "1" when LF code is sent.)
DT1	(CR) (LF) (ETX) (ETX code: X 0 0 0 0 0 1 1)

(c) Measurement start command
Measurement can be started by GET command (code X 0 0 0 1 0 0 0) or RS [RESET] program code.

(d) Input range: IN [INPUT]

Code	Function
IN10	INPUT1, 10 Hz ~ 200 MHz, input impedance 50 Ω
IN11	INPUT1, 10 Hz ~ 200 MHz, input impedance 1M Ω
IN2	INPUT 2, 0.2 ~ 18 GHz, input impedance 50 Ω

(e) Measurement resolution: RE [RESOLUTION]

Code	Function
RE2	Resolution 0.1 Hz (gate time 10s)
RE3	Resolution 1 Hz (gate time 1s)
RE4	Resolution 10 Hz (gate time 0.1s)
RE5	Resolution 100 Hz (gate time 10ms)
RE6	Resolution 1 kHz (gate time 1ms)
RE7	Resolution 10 kHz (gate time 0.1ms)
RE8	Resolution 100 kHz (gate time 10µs)
RE9	Resolution 1 MHz (gate time 1µs)
RE13	HI RESOL, 1 mHz (10 Hz to 1 MHz, gate time max. 20s)
RE14	HI RESOL, 10 mHz (10 Hz to 10 MHz, gate time max. 16s)
RE15	HI RESOL, 0.1 Hz (10 Hz to 20 MHz, gate time max. 5s)
RE16	HI RESOL, 1 Hz (10 Hz to 20 MHz, gate time max. 0.5s)

Program codes RE13 to RE16 are valid only during INPUT1 range operation.

(f) Sample rate: SR [SAMPLE RATE]

Code	Function
SR0	Sample rate on front panel.
SR1	Infinite (HOLD)
SR2	Fast sample (no delay).

(g) Manual mode select: MA [MANUAL]

Code	Function
MA0	MANUAL mode OFF (AUTO mode)
MA10	MANUAL mode ON with measured value as manual set value.
MA11 xxxxx (Data)	MANUAL mode ON with data as manual set value.

This program code is valid only during INPUT2 range operation. The data of the MA11 program code represent nonfixed length data string of up to 5 characters, in MHz units. If this data is omitted, the previously set value is implied.

[Example] MA1112450 ... Manual setting 12.45 GHz
MA11865 ..... Manual setting 865 MHz

(h) Offset mode select: OF [OFFSET FREQUENCY]

Code	Function
OF0	OFFSET mode OFF.
OF10 ± (Sign)	OFFSET mode ON with measured value as offset value.
OF11 ± xxxxx.x..x (Sign, Data)	OFFSET mode ON with data as offset value.
OF20 ± (Sign)	OFFSET mode ON with measured value as initial set value and set value changed after each measurement.
OF21 ± xxxxx.x..x (Sign, Data)	**OFFSET mode ON with data as initial set value and set value changed after each measurement**

When the sign of the program code is +, the addition OFFSET mode is selected. When it is

-, the subtraction OFFSET mode is selected. The + sign can be omitted.
The data of program codes OF11 and OF21 can be up to 12 digits + decimal point, in MHz units. However, during HI RESOL operation, the data is 11 digits + decimal point, in kHz units. If the data is omitted, the previously set value is implied.

[Example] OF11 + 765.34 ... Offset setting 765.34 MHz addition OFFSET mode
OF11 - 12450.5 .. Offset setting 12.4505 GHz subtraction OFFSET mode

(i) Ratio mode select: RA [RATIO]

Code	Function
RA0	Ratio (ppm) mode OFF
RA1	Ratio (ppm) mode ON

The RA1 program code is effective only during subtraction OFFSET mode operation.
If the program code RA0 is specified in the ratio mode, operation switches to the subtraction OFFSET mode.

(j) Burst mode select: BU [BURST]

Code	Function
BU0	Burst mode OFF
BU1	Burst mode ON

(k) Amplitude discrimination function:
AD [AMPLITUDE DISCRIMINATION]

Code	Function
AD0	Automatic amplitude discrimination (MANUAL AMPL DISC mode OFF)
AD10	Optimum AUTO value setting and MANUAL AMPL DISC mode ON.
AD11 ×␣ Data	Data made the set value and MANUAL AMPL DISC mode ON.

These program codes are only valid during INPUT2 range operation.
The data of program code AD11 is a one digit number from 0 to 7. Data 0 is the minimum sensitivity when the input signal level is high (HIGH LEVEL). Data 7 is the maximum input sensitivity when the input signal level is low (LOW LEVEL).

(l) Self-check operation: CK [CHECK]

Code	Function
CK0	Self-check operation OFF
CK1	Self-check operation ON

(m) Output mode: OM [OUTPUT MODE]

Code	Function
OM0	Repeat measurement until addressed.
OM1	Wait until addressed.

See paragraph 6.5 for a detailed description of the output modes. When the measurement function is controlled, one measurement is

performed even in the OM1 mode.
If the MF76A is switched from the remote mode to the local mode during OM1 mode operation, the output mode does not change.

(3) Initial value

The following initial values are set when the power is turned on or by universal command DCL, addressing command SDC (code: [X|0|0|0|0|1|0|0]) and program code CL [CLEAR].

Item	Initial value
Input	INPUT 2 (IN2)
Resolution	1 kHz (RE6)
Sample rate	Front panel sample rate mode 80 ms (SR0)
Auto-manual	AUTO (MA0)
Offset	OFF (OF0, RA0)
Burst	OFF (BU0)
Amplitude discrimination	AUTO AMPL DISC (AD0)
Self-check	OFF (CK0)
Service request	All DISABLE (RQ0)
Data terminator	LF∧END (DT0)
Output mode	OM0 mode (OM0)
Set data	Cleared.

(4) Function modification and combination error

(a) Operating mode modification accompanying range switching

(i) When MF76A switched from INPUT 2 range operation to INPUT 1 range operation

MANUAL mode operation	OFF (MA0)
MANUAL AMPL DISC mode operation	OFF (AD0)
OFFSET mode operation	OFF (OF0)

(ii) When MF76A switched from INPUT 1 range operation to INPUT 2 range operation

OFFSET mode operation	OFF (OF0)
HI RESOL mode operation	OFF (RESOLUTION before RE13 - RE16 specified)

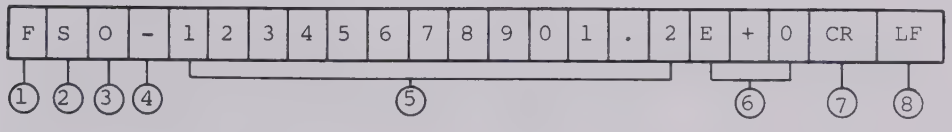
(b) Combination error

Combination error corresponds to an order error during front panel key operation. For example, if the following program code combinations are specified, a combination error is recognized, and the command ("MA10" of "IN10, MA10") is ignored.

"IN10,MA10"
"IN10,AD10"
"IN2, RE15"
"CK1, AD10"
"CK1, BU1"
"CK1, RE15"
"OF0, RA1"
"OF10+,RA1"

(5) Talker format (data-output format)

If the MH76A is addressed to talk, the LED in the front panel RECALL key lights, and the MF76A outputs measurement data in accordance with the general format shown below.



① F: Frequency (units Hz)
R: Ratio (units ppm)

② S: Offset ON
Space: Offset OFF

③ 0: Overflow
Space: Normal

④ -: When sign of data is -.
Space: When sign of data is +.

⑤ Data 12 digits + decimal point
Leading zeros (blanked zeros) are sent as 0 and are not spaces.

⑥ E + 0: Data exponent 10^0
E + 3: Data exponent 10^3
E + 6: Data exponent 10^6
E + 9: Data exponent 10^9

⑦ CR: Carriage return

⑧ LF^END: Initial setting, DT0 specified (EOI line is made "1" in synchronization with LF code.)
LF ETX: DT1 specified (ETX code output after LF code.)

(a) Data output format change

(i) Measurement resolution

RESOLUTION	F S O −	1 2 3 4 5 6 7 8 9 0 1 . 2	E + 0	CR LF
0.1 Hz	F # #	1 2 3 4 5 6 7 8 9 0 1 . 2	E + 0	CR LF
1 Hz	F # #	0 1 2 3 4 5 6 7 8 9 0 1 .	E + 0	CR LF
10 Hz	F # #	0 0 1 2 3 4 5 6 7 8 . 9 0	E + 3	CR LF
100 Hz	F # #	0 0 0 1 2 3 4 5 6 7 8 . 9	E + 3	CR LF
1kHz	F # #	0 0 0 0 1 2 3 4 5 6 7 8 .	E + 3	CR LF
10kHz	F # #	0 0 0 0 0 1 2 3 4 5 . 6 7	E + 6	CR LF
100kHz	F # #	0 0 0 0 0 0 1 2 3 4 5 . 6	E + 6	CR LF
1MHz	F # #	0 0 0 0 0 0 0 1 2 3 4 5 .	E + 6	CR LF
HI RESOL 1 mHz	F # #	0 1 2 3 4 5 6 7 . 8 9 1 0	E + 0	CR LF
HI RESOL 10 mHz	F # #	0 0 1 2 3 4 5 6 7 . 8 9 0	E + 0	CR LF
HI RESOL 100 mHz	F # #	0 0 0 1 2 3 4 5 6 7 . 8 0	E + 0	CR LF
HI RESOL 1 Hz	F # #	0 0 0 0 1 2 3 4 5 6 7 . 0	E + 0	CR LF

(ii) Ratio measurement

Ratio (ppm) operation	R S #	0 0 0 0 0 0 0 1 2 3 4 . 5	E + 0	CR LF

(iii) Overflow

	OFFSET operation	# S O	9 9 9 9 9 9 9 9 9 9 9 9 .	E + 9	CR LF
*1	HI RESOL operation	# # O	0 0 0 0 0 0 0 0 0 0 0 . 0 0	E + 0	CR LF

*1: The decimal point position changes with the specified resolution, and the data may not be 0.

(b) Status output

When the MF76A is addressed to talk in SPMS (SERIAL POLL MODE STATE), it outputs one byte status.

The status byte is described below.

DIO8	7	6	5	4	3	2	DIO1
0		1	1	0			

DIO1: "1" at the end of measurement. Otherwise "0".

DIO2: "1" when a program code not used by the MF76A is detected in a command string received by the MF76A as a listener, or when the data range is exceeded. Otherwise "0". (Format error)

DIO3: "1" when a program code that does not use a combination function is detected in the command string received by the MF76A as a listener, or when a program code that cannot be combined with the function being performed is detected. Otherwise "0". (Combination error)

DIO7: "1" when the MF76A generates an SRQ (SERVICE REQUEST). Otherwise "0".

Note) An SRQ is generated at the end of measurement, when a format error is detected, and when a combination error is detected according to the specified RQ program code. See paragraph 6.4.3 (2)(a) for a description of the ENABLE /DISABLE method.

6.5 DATA TRANSMISSION OPERATION AND TIMING

Fig. 6-7 is the data transmission operation flow chart.

In OM0 mode and sample rate is other than HOLD (SR1), the MF76A checks to see if it has been addressed to talk at the end of a measurement. If not, SRQ (SRQ ENABLE mode) and the measurement end bit (LSB of the status byte) are cleared and it starts the next measurement (count after sample rate).

If it has been addressed to talk, it outputs the measurement data at the end of a measurement, then clears SRQ and the measurement end bit, and starts the next measurement.

In OM1 mode and sample rate is other than HOLD (SR1), the MF76A waits in a loop until it has been addressed to talk at the end of a measurement. When it is addressed to talk, it outputs the measurement data, clears SRQ and the measurement end bit, and starts the next measurement.

In other than HOLD mode, if the MF76A addressed to talk immediately after the measurement data output, it does not output the measurement data repeatly and outputs the next measurement data at the end of the next measurement.

In HOLD mode, when the MF76A is addressed to talk after the trigger command (GET, RS) output, it output the measured data.

If it is addressed to talk before the trigger command output, it outputs the previous measurement data.

Note) The MF76A is automatically triggered and begins measurement immediately after execution of the various function setting commands by addressing to listener.

Fig. 6-8 shows the talker specification data transmission timing.

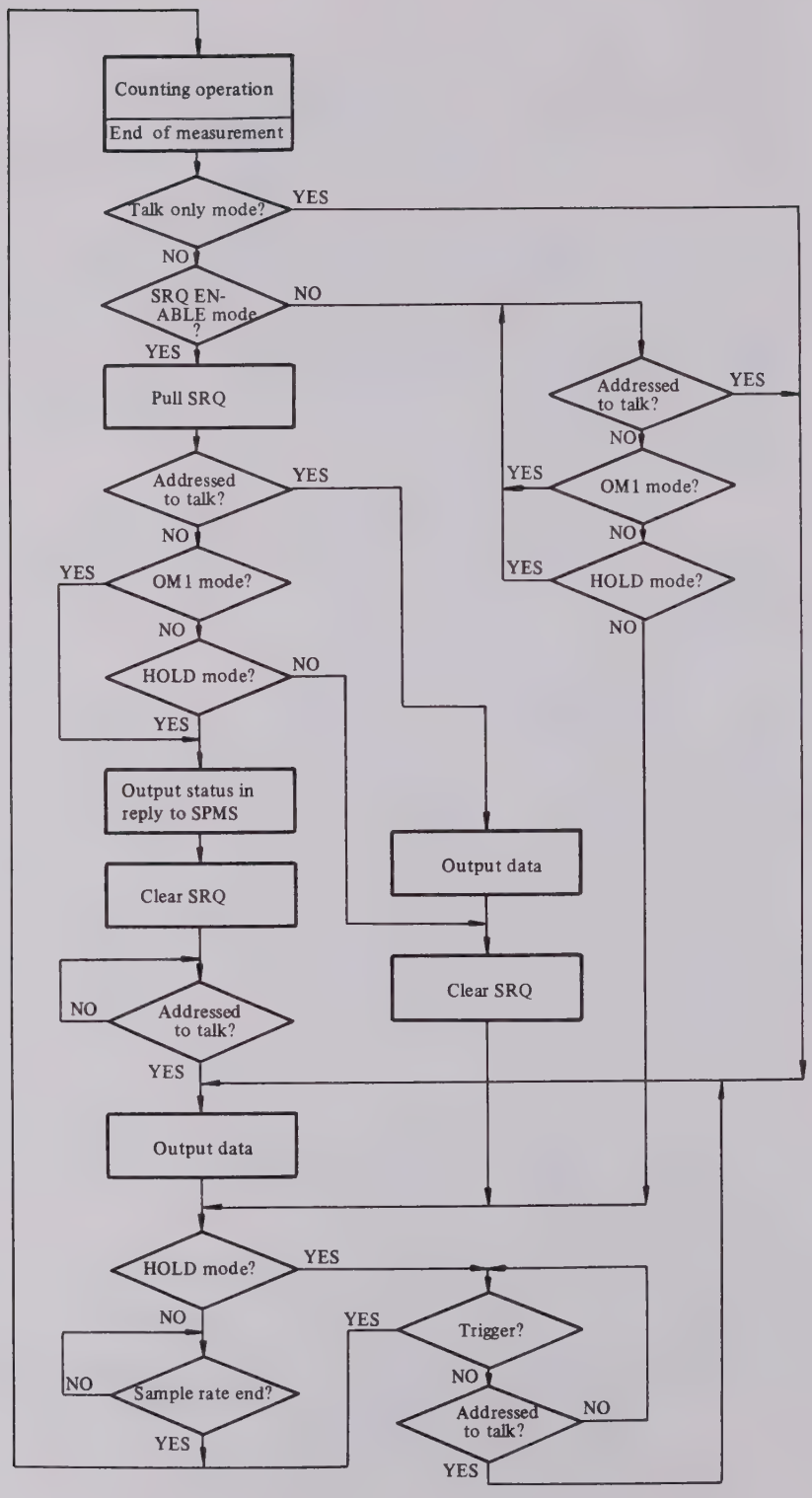
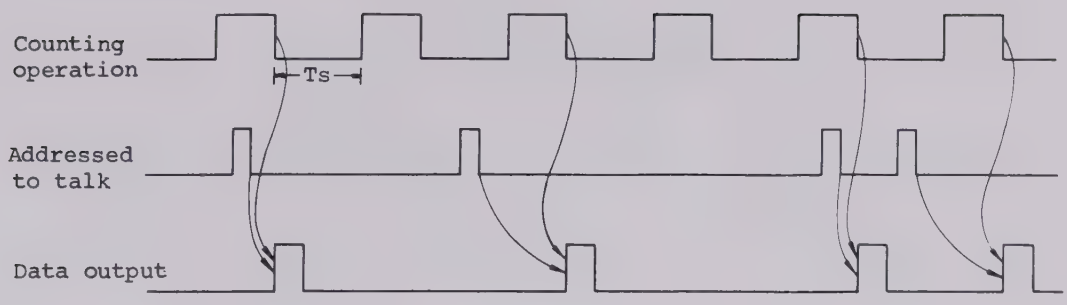
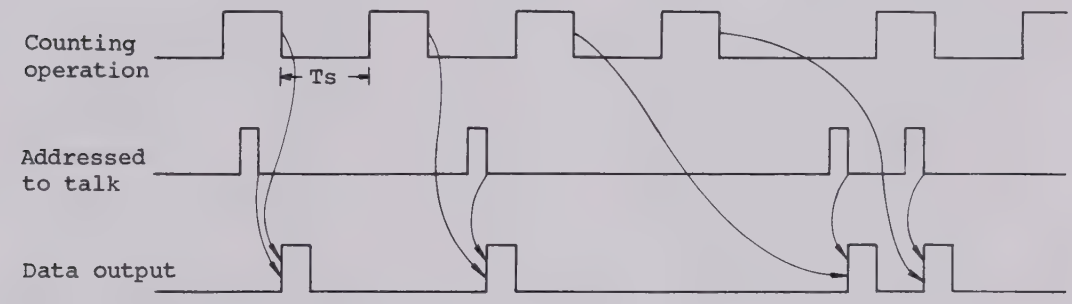


Fig. 6.7 Data transmission flow chart

(a) OM0 mode (sample rate Ts)



(b) OM1 mode (sample rate Ts)



(c) Sample rate Hold mode

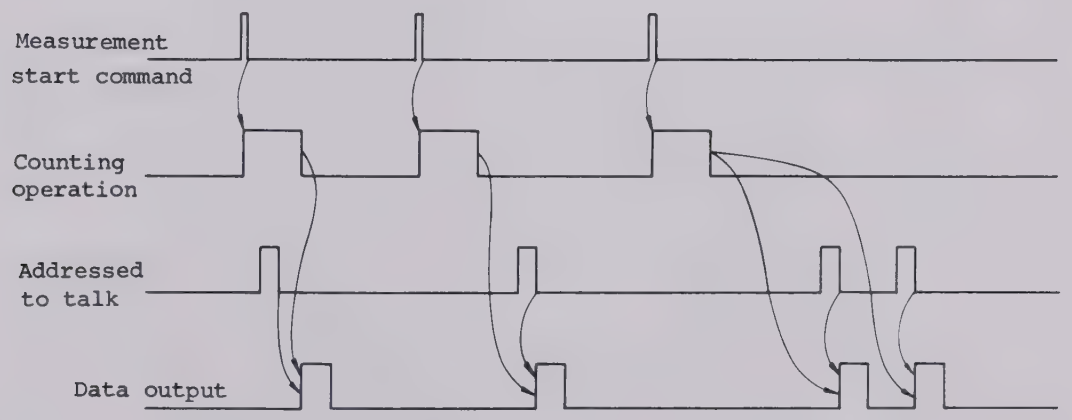


Fig. 6.8 Data transmission timing

6.6 SAMPLE PROGRAMS

This section describes several sample control programs when the MF76A is controlled by PACKET II HIGH PERSONAL COMPUTER. (The address of the MF76A is the same as the setting shown in Fig. 6-5; only A1 is "1".)

[Example 1] Measure an 18 GHz signal in the AUTO mode and at a 1 Hz resolution, and fetch and print the measured data every 10 seconds.

Sample program and data

```
10 DIM A$*30
20 WRITE @101:"CL FET"
30 STATUS @101:I
40 PRINT "STATUS  ";BSTR$(I,8)
50 READ @101:A$
60 PRINT A$
70 WAIT DELAY 10
80 GO TO 50
90 END



STATUS  00110000
 +0.180000000000E-3
 +0.180000000000E+0
 +0.180000000000E+0
 +0.180000000000E+0
 +0.180000000000E+0
```

Program explanation

10: Define dimension.

20: Initialize (INPUT 2, AUTO, front panel sample rate) and set resolution to 1 Hz.

30: Read the status for error check.

40: Print status as an 8 bit binary number.

50: Read data.

60: Print data.

70: Wait 10 seconds.

80: Return to line 50.

[Example 2] Set the MF76A to HOLD and 0.1 Hz resolution on the INPUT 1 range, apply a trigger, and fetch the data. Repeat every 10 seconds.

Sample program and data

```
10 DIM A$*10
20 WRITE @101:"IL INI SEL SR1"
30 STATUS @101:I
40 PRINT "STATUS ";I
50 WRITE @101:"R5"
60 READ @101:A$
70 PRINT A$
80 WAIT DELAY 10
90 GO TO 50
100 END



STATUS  00110000
R    +0.16836961E+0
R    +0.16836987E+0
R    +0.16836947E+0
R    +0.16836929E+0
R    +0.16836958E+0
```

Program explanation

10: Define dimension.

20: Initialize and set INPUT 1 range, 0.1 Hz resolution, HOLD sample rate.

30: Read status for error check.

40: Print status as an 8 bit binary number.

50: Apply trigger.

60: Read data.

70: Print data.

80: Wait 10 seconds.

90: Return to line 50.

[Example 3] Measure a 1 MHz signal at 1 mHz resolution and fast sample rate, and fetch and print the data 10 times.

Sample program and data

```
10 DIM A$*20
20 OUTPUT @101;"CL.IN1.RE1.
   OM1.SP2"
30 LET K=10
40 ENTER @101;A$
50 PRINT A$
60 LET K=K-1
70 IF K<>0 THEN 40
80 END
```

```
 +1.0000001.8650E-0
 +1.0000001.7280E-0
 +1.0000001.5720E-0
 +1.0000001.4040E-0
 +1.0000001.2170E-0
 +1.0000001.0410E+0
 +1.0000000.8560E+0
 +1.0000000.6630E+0
 +1.0000000.4650E+0
 +1.0000000.2710E-0
```

Program explanation

10: Define dimension

20: Initialize and set INPUT 1 range, HI RESOL operation, 1 mHz resolution, OM1 output mode, no-delay fast sample rate.

30: Number of data fetches (10 times).

40: Read data.

50: Print data.

60: Decrement number of times by one.

70: If number of times is insufficient, return to line 40.

80: End of program.

[Example 4] Fetch and print the frequency difference from the standard value by -OFFSET operation in the MANUAL mode.

Sample program and data

```
10 DIM A$*30
20 WRITE @101:"CL SP2;FA16750
   OF1:-6375.14;OM1"
30 STATUS @101:S
40 IF S=48 THEN 30
50 READ @101:A$
60 PRINT "STATUS  ";S;"ENTR$ ";E;D;
70 PRINT A$
80 GO TO 30
90 END
```

```
STATUS  00110001
FS -0000000000127.E+3
STATUS  00110001
FS -0000000000126.E+3
STATUS  00110001
FS -0000000000126.E+3
STATUS  00110001
FS -0000000000126.E+3
```

Program explanation

10: Define dimension.

20: Initialize (INPUT 2 range, 1 kHz resolution) and set no-delay fast sample rate, 6.35 GHz set value MANUAL mode, 6375.14 MHz standard value -OFFSET, OM1 output mode

30: Read status.

40: If not measurement end, return to line 30.

50: Read data.

60: Print status.

70: Print data.

80: Return to line 30.

[Example 5] Set measurement end service request to ON, apply trigger from controller, when necessary, and fetch and print the data when a measurement end interrupt is generated.

Sample program and data

```
 10 PROCESS EVENT GP_SRQ"@01,01"
 20 WRITE @101:"CLRE4RO1SR1OM1
   OFI:-11202.5RW1"
 30 CONNECT EVENT GP_SRQ
 40 START GPIB
 50 GO TO 50
 60 END
 70 PARACT GPIB URGENCY 50
 80 DIM A$*30
 90 WAIT EVENT GP_SRQ
100 STATUS @101:S
110 READ @101:A$
120 PRINT "STATUS  ";BSTR$(S,8)
130 PRINT A$
140 WRITE @101:"RS"
150 GO TO 90
160 END PARACT
```

```
STATUS  01110001
RS  00000000043.0E+0
STATUS  01110001
RS  00000000043.0E+0
STATUS  01110001
RS  00000000043.0E+0
STATUS  01110001
RS  00000000043.0E+0
```

Program explanation

10: Define GPIB SRQ interrupt event.

20: Initialize (INPUT 2, AUTO), and set resolution 10 Hz, interrupt ENABLE at end of measurement, sample rate HOLD, OM1 output mode, -OFFSET mode with 11202.5 MHz set value, ppm display mode (First trigger is applied by execution.)

30: Enable interrupt.

40: Start parallel processing section "GPIB".

70: Define parallel pro cessing section "GPIB" priority order.

80: Define dimension.

90: Wait for GPIB SRQ interrupt.

100: Read status.

110: Read data.

120: Print status as 8 bit binary number.

130: Print data.

140: Apply trigger.

150: Return to line 90.

SECTION 7

MAINTENANCE

7.1 SAFETY PRECAUTIONS FOR MAINTENANCE AND REPAIR

Turn off the POWER switch (1) (* and the LINE switch (23)) and unplug the power cord from the ac line prior to removing the chassis from the cabinet for maintenance or repair.

Never touch the interior of this instrument unless the power cord has been unplugged. If the interior of the instrument must be touched, turn the POWER switch on and off again because the capacitor may be charged.

* --- For IEC Safety Standard

7.2 REPLACING POWER FUSE

The primary side fuse is on the rear panel.

The secondary side fuse is on the rear printed-circuit board inside the instrument. The top cover must be removed to replace the secondary side fuse. Only use fuses with the specified rating.

7.3 PERFORMANCE CHECK

For checking functions and performance, verify the operations in accordance with paragraph "3.4 Preparations for Measurement". Follow the instructions given below to verify and determine whether or not the performance satisfies the specifications:

(1) Prepare a signal generator with frequency range of 0.2 to 18 GHz and a power meter that can be used within the frequency band.

(2) Turn off the POWER switch (1) of this instrument once. Then, turn it back on to initialize the instrument.

(3) Connect the output connector of the signal generator and the input connector of the power meter using the attached measuring coaxial cable.

(4) Align the reading of the power meter with the rated sensitivity of this instrument by adjusting the output level of the signal generator.

Input sensitivity	-22 dBm:	0.2 to 14 GHz
	-15 dBm:	14 to 18 GHz

(5) Remove the measuring coaxial cable from the input connector of the power meter and connect it to the INPUT 2 connector (5).

(6) Verify that the output frequency of the signal generator is displayed on the display (12).

(7) Remove the coaxial cable from the INPUT 2 connector (5) and verify that the output frequency is correctly displayed by varying the output frequency and repeating the operations in (3) through (6) above.

(8) Prepare a signal generator with frequency range of 10 Hz to 200 MHz.

(9) Push the INPUT SELECT key (6) to light up the LED on the INPUT 1 side.

(10) If the output impedance of the signal generator is 50 Ω, set the input impedance to 50 Ω (the LED in the key is off) by pushing the 50Ω/1MΩ key (7). If the output impedance of the signal generator is other than 50 Ω, set the input impedance to 1 MΩ (the LED in the key lights), and use a feedthrough-type fixed terminater having the same value as the output impedance of the signal generator on the INPUT 1 side connector (4).

(11) Adjust and align the output level of the signal generator with the rated sensitivity of this instrument (50 mVrms).

(12) Connect the output connector of the signal generator and the INPUT 1 connector (4) using the attached measuring coaxial cable.

(13) Verify that the output frequency of the signal generator is displayed on the display (12).

(14) Vary the output frequency of the signal generator and verify that the frequency is displayed correctly.

7.4 REPACKING

It is recommended that this instrument be put in the storage trunk (optional accessory) for transport. If no storage trunk is available, pack the instrument in the manner described below to prevent any possible damage during transport:

(a) Wrap the counter in vinyl.

(b) Use a sturdy cardboard box and surround the instrument with at least 50 mm of packing material.

(c) Put packing material on top of the instrument. Place the accessories in the accessory box with more packing material. Tie the box securely with cord.

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